

RECONNAISSANCE VEGETATION STUDY OF
THE BLUESTONE, NEW, AND GAULEY
RIVER GORGES

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Prepared for: NATIONAL

PARK SERVICE

Order No. 1443PX478094215
Requisition No. 1732

March 30, 1995

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INTRODUCTION

During the summer and fall of 1994, a reconnaissance study was conducted on the vegetation of the Bluestone, Gauley, and New River Gorges. Also, a "walk-through" type survey was conducted on the north side of the Meadow River Gorge, down stream from the bridge on U.S. Route 19, in search of possible old-growth forest stands or old individual trees.

The study was initiated with four objectives:

- 1) To evaluate the scientific literature for this and similar areas, including a correlation of geomorphology and geology of the gorges and possible plant community and species distribution patterns.
- 2) To establish one sample transect in each of the three gorges in order to collect quantitative data for composition and structure of the vegetation along elevational gradients; extract tree cores to determine the ages of a representative number of dominant or codominant trees; and to collect and analyze soil samples to characterize the substrate of study sites.
- 3) To conduct spot vegetation sampling in four to six (estimate) rock and cliff zones - to collect additional tree core age data.
- 4) To complete an analysis of the data and literature to present in a preliminary report.

The initial proposal for this project was for a more extensive sampling program and for the development of a vegetation map for each of the three gorges. However, this was not feasible because of time and funding constraints. A reconnaissance investigation was selected rather than a more intensive, broader-scoped study for several reasons:

- 1) Accessibility is difficult over much of the study area. A preliminary study would permit a more efficient, focused follow-up investigation by: (a) increasing familiarity with the area, (b) identifying the most interesting and important sites for future investigations, and (c) identifying the most critical parameters to include in future studies.
- 2) Data collection methods could be tested and refined, adding to the efficiency of later studies.
- 3) An additional year to prepare for a more comprehensive study would allow a more thorough search of the literature and more time to consult with local and regional experts in geology, soils, logging history, etc.

BACKGROUND AND LITERATURE REVIEW

Relatively little is known about the vegetation of the New River Gorge National River and adjacent Gauley River National Recreation Area and Bluestone National Scenic River, simply because the appropriate studies have never been conducted. This paucity of information can be, in part, attributed to the rugged topography and relative inaccessibility of the gorges.

A review of the published literature on the vegetation of this region confirmed this dearth of information. Sturm (1977) described the plant communities of the Bluestone River Gorge within Pipestem State Park as part of an ecoregion study in West Virginia. Oxley (1975) studied the floristics and plant communities of the portion of the Indian Branch drainage basin within Pipestem State Park. Otherwise, most botanical studies in the three gorges have been largely floristic surveys. Floristic studies were conducted by Phillips (1969) in the New River Gorge between Glen Lyn and Gauley Bridge, by Norris (1992a, 1992b)) in the Gauley River and New River Gorge and in the Meadow River Gorge down stream from the U.S. Route 19 bridge, and by Grafton (1993) in the Gauley, Meadow, and Bluestone River Gorges.

This portion of southern West Virginia falls within the Mixed Mesophytic Forest Region as mapped by Braun (1950), but many of the forest communities appear rather similar in composition to those of the Appalachian Oak Forest Region as described by Stephenson et al. (1993). Recognized forest types in the gorges include oak-hickory, mixed oak, oak-maple, oak-yellow pine, hemlock-hardwoods, northern hardwoods, cove hardwoods, and bottomland and floodplain hardwoods (U.S. Department of Interior, 1977). These occur on three general types of sites-riparian, upland slopes, and rim/highland plateau.

Given the ostensible paucity of studies and the general lack of details known about the species diversity and distribution and plant community composition, it is somewhat surprising that a rather large number of rare plant taxa, at least on a regional basis, have been reported from the New River Gorge region (Strausbaugh and Core, 1970, 1971, 1973, and 1980). Many of the records cited are a result of collections made in the late 1800s and early 1900s in the New River

Gorge region by two early West Virginia botanists, L. W. Nuttall and C. F. Millspaugh.

Core (1966) recognized the New River as an important corridor for plants entering West Virginia. The New, because it is a geographically old river which flows into the state from the south, is an important migratory route for many plant species indigenous to the Southern Appalachians. The silverbell (*Halesia Carolina*), for example, doubtless entered the state via the New River. An uncelebrated species and one usually considered an invasive exotic, kudzu (*Pueraria lobata*), also used the New River on its migratory route north.

Another important aspect of the gorges is the occurrence of several special habitats. These sites include rock dominated terrain—rocky river banks [habitats for several rare and endangered species, including the Virginia spiraea (*Spiraea virginiana*)], rock outcrops, cliff faces, and many waterfalls. Because of the steep gorge walls and depth of the gorges, combined with the sun-exposed rocks on the gorge rims, extremes in moisture availability are common. These extremes, which range from xeric to mesic, provides a wide diversity of plant habitats.

A noteworthy aspect of the many rock outcrops and cliff faces of the three gorge area is the potential for the occurrence of old-growth stands or at least the occurrence of individual trees of exceptional old age. This includes the occurrence of such species as red cedar (*Juniperus virginiana*), hemlock (*Tsuga canadensis*) and oaks (*Quercus* spp.). Because rock escarpments are potential sites for old age (>150 years) trees (Larson et al. 1989), these habitats were given special attention.

Rock escarpments, in general, have been given little attention in terms of their overall vegetational features (Larson et al., 1989). Recent studies carried out elsewhere in North America (e.g., Larson and Kelly, 1991) have shown that cliff face communities, because of their relative inaccessibility, small size, and the poor growth form of the trees present, often remained relatively undisturbed when the surrounding forests were cut. As a consequence, some of the oldest living trees (>700 years) in eastern North America have been reported from cliff faces of the Niagara Escarpment in southern Ontario, Canada. Finding and studying old trees in the three-gorge area could provide tree ring chronologies that would contribute greatly to the

understanding of climatic patterns in the region during the past few hundred years. Detailed dendrochronological studies could also help establish natural fire frequencies prior to the arrival of colonial Europeans. Dendrochronological studies of this type are almost completely lacking for the mid-Appalachians.

METHODS

The techniques of direct gradient analysis (Gauch, 1982) were utilized to study patterns of vegetation in the three gorges. A transect consisting of a series of three 20 by 50 m (0.1 ha.) quadrats (one each at upper, mid-, and lower slope positions) was established at one locality in each gorge. The transect locality was considered to be representative (i.e., with respect to topography and vegetation) of the gorge and was selected on the basis of information obtained from a reconnaissance of the general study area and examination of 7.5 minute topographic maps. (Transect locations and cites for tree core sampling are shown on Figures 1, 2, 3, and 4.) Each transect extended from the riverbank to the top of the gorge. The Bluestone Gorge transect was located within Pipestem State Park in an area near the park aerial tramway (Fig. 1). The New River transect was located south of the bridge over the New River on U.S. Route 19 and near the peregrin falcon hacking site (Fig. 2); Two sites were sampled in the Gauley—a transect established at Carnifex Ferry State Park (Fig. 3) and two plots sampled at Koontz Bend (Fig. 4).

Composition and structure of the vegetation were determined using standard sampling methods (e.g., Stephenson and Adams, 1986). Diameters at breast height (1.37 m above the ground level and hereafter referred to as DBH) of all live stems of trees ($j > 10$ cm DBH) and small trees (2.5 to 9.9 cm DBH) were recorded by species in the 0.1 ha. quadrats. Saplings (individuals of tree species < 2.5 cm DBH but > 1.0 m tall) were tallied by species in this same quadrat. Numbers of seedlings (individuals of tree species < 1.0 m tall) and shrubs (including woody vines) were recorded by species in four 5.0 by 5.0 m plots placed at regular intervals along a 50 m tape used to establish the center line of the 0.1 ha quadrat parallel to the contour of the slope. Estimates of percent cover of herbaceous plants, exposed rock, wood debris, and bryophytes were recorded from ten 1.0 by 1.0 m plots placed at 5.0 m intervals along the same tape. All cover values were estimated using a cover class rating scale described by Daubenmire (1968). Additional species not encountered within these plots but observed within the larger 0.1 ha. quadrat also were recorded. In the New River Gorge, because the slope was long, two additional plots (located at upper mid- and lower midslope positions) were

sampled to provide a more detailed representative sample of the vegetation along slope gradient. In these two plots, only data on the composition of the tree, small tree, and sapling strata were collected. For the Gauley River Gorge, two additional plots were sampled at Koontz Bend where data were selected to sample large tree, small tree, and sapling strata. Site selection for the quadrats was based on the trying to sample potentially old-growth forests, and not sampling along a slope gradient. Like the other sample site, the center of each 0.1 ha. quadrat was permanently marked with a metal stake and its position determined by means of a portable global positioning system.

Field data were used to calculate relative basal area and relative density values separately for trees and small trees. Only relative density values were derived for sapling, seedlings, and shrubs. Relative cover and relative frequency were determined for herbaceous plants. Species importance value indices for trees and small trees were calculated as one-half the sum of relative basal area and relative density, and for herbaceous plants as one-half the sum of relative cover and relative frequency. Shannon's formula (Shannon and Weaver, 1963) was used to calculate a value of species diversity for the tree stratum at each locality, using importance values indices as inputs.

Increment growth cores were extracted at breast height from several dominant or codominant trees in and around each quadrat for age determination. Cores were obtained from several additional localities in the New River Gorge, mostly along the cliff faces upstream of U. S. Route 19 (Fig. 5). Cores were also obtained from trees at the top of a cliff face in the Meadow River Gorge down stream of Route 19. In the laboratory, all cores were air dried, glued in grooved boards, and sanded; growth rings were counted using a binocular microscope.

Soil samples were collected from the upper 10 cm in each quadrat, mixed thoroughly, and placed in plastic bags. Samples were later oven-dried and passed through a 1.0 cm sieve to remove gravel. Percent organic matter and pH were determined and analyses of content in parts per million for phosphoric acid, calcium, magnesium, potassium, zinc, nitrate nitrogen, and manganese, and total soluble salts were carried out by the Soil Testing Laboratory, Virginia Polytechnic Institute and State University, using procedures outlined by Donohue and Friedericks (1984).

The taxonomic nomenclature follows Strausbaugh and Core (1970, 1971, 1974, 1980).

RESULTS

General Characteristics

Overall, tree densities at all localities were generally similar, ranging from 200 (Bluestone River) to 575 (New River). Basal area of trees was greatest on the upper and midslope positions at Carnifex Ferry State Park. Species richness and Shannon diversity indices for trees at all localities were similar. The youngest cored tree was on the New River (29 rings) at midslope, whereas the oldest was cored on the upper slope at Carnifex Ferry State Park on the Gauley River (306).

Gauley River (Tables 1 and 2) --At the Carnifex Ferry State Park locality, the slopes were not particularly steep and exhibited a generally southerly exposure. The older trees occurred at the mid- and upper slope positions; by contrast, trees on the lower slope were very young. Density of small trees was similar to that of the canopy trees. Small tree, shrub, and sapling density increased down slope, whereas seedling density decreased. At the Koontz Bend locality, the slopes were much steeper and generally had a northwest aspect.

Bluestone River (Table 3)—Forest communities studied along this river at Pipestem State Park were on very steep, southwesterly slopes. Trees at all points along the transect were comparably aged, although the oldest tree cored was at midslope. Small tree and sapling density increased down slope, whereas seedling and shrub density decreased.

New River (Table 4)—Slopes of this gorge were very steep and had a southeasterly exposure. Trees were generally young and comparably aged along the slope gradient. Small tree and seedling densities decreased down slope. Sapling and shrub densities were highest at midslope.

Trees

Generally speaking, more mesic species were found in the Gauley River Gorge than in either of the other gorges. In the New River and Bluestone River systems, upper slope species were typically more xeric, with more mesic species becoming dominant on the lower slopes.

Gauley River (Tables 5 and 6)—At the Carnifex Ferry State Park site, hemlock (*Tsuga canadensis*) was dominant on the upper and midslope (IV=38.4 and 33.1, respectively). White oak (*Quercus alba*) was an important associate of hemlock at midslope (IV=19.3), but this species was absent from the lower slope where northern red oak (*Q. rubra*), yellow birch (*Betula allegheniensis*), and tulip poplar (*Liriodendron tulipifera*) became important. Black birch (*B. lento*) (IV=18.5) and tulip poplar also were important at the lower slope position. At Koontz Bend, hemlock was the clear dominant in both sampled stands, which occurred at midslope and lower midslope (IV=68.6 and 42.0, respectively).

Bluestone River (Table 7)—At Pipestem State Park, white oak was dominant on the upper slope (IV=37.8), whereas chestnut oak (*Q. prinus*) (IV=34.3) shared dominance with both white (IV=30.6) and northern red oak (IV=24.7) at midslope. On the lower slope (near the river), white pine (*Pinus strobus*) (FV=24.5) was dominant, with northern red oak (IV=17.2) and green ash (*Fraxinus lanceolata*) (IV=16.0) the most important associates.

New River (Table 8)—Chestnut oak and black oak (*Q. velutina*) shared dominance (IV=35.0 and 22.2, respectively) on the upper and upper midslope (IV=63.3 and 15.6, respectively) positions. At midslope, pignut hickory (*Carya glabra*) (V=32.4) and tulip poplar (IV=25.8) shared dominance, whereas tulip poplar (IV=33.5) was dominant on the lower midslope, with black locust (*Robinia pseudo-acacia* (IV=18.8) and pignut hickory (IV=17.6) occurring as important associates. On the lower slope position, northern red oak and sugar maple (*Acer saccharum*) were codominant (IV=24.9 and 21.8, respectively).

Small trees

Gauley River (Tables 9 and 10)—At the Carnifex Ferry site, hemlock dominated on the upper slope (IV=46.2) and especially on the midslope (IV=90.3). Dominance was shared by yellow birch (IV=33.6) and witch hazel (*Hamamelis virginiana*) (IV=33.4) on the lower slope. At Koontz Bend, hemlock was clearly dominant in both sampled stands (IV= 100.0 and 47.2), which occurred at lower-mid and midslope positions. Sugar maple (IV=22.5) was second in importance in one stand.

Bluestone River (Table II)--Sugar maple was dominant at all three slope positions [IV=25.9 (upper slope), 29.2 (midslope), and 52.1 (lower slope)]. Only at the upper slope position was another species, dogwood (*Cornus floridd*) (IV=23.1), codominant.

New River (Table 12)—Chestnut oak (IV=29.0) was dominant only on the upper midslope, where it shared dominance with pignut hickory (IV=25.4). At the upper slope position, sourwood (*Oxydendrum arboreuni*) (IV=24.9) was dominant, whereas sugar maple was dominant at the lower mid- (IV=68.5) and lower slope (IV=78.3) positions. At midslope, dominance was shared almost equally by red maple (*Acer rubrum*), sassafras (*Sassafras albidum*), and black gum (*Nyssa sylvatica*) (IV=15.3, 15.3, and 17.0, respectively).

Saplings and seedlings

Gauley River (Tables 13 and 14)—Sapling diversity was greatest on the lower slope, but seedlings displayed nearly equal diversity along the elevational gradient. Hemlock dominated the sapling stratum at the upper and midslope positions, with witch hazel dominant on the lower slope. Among seedlings, striped maple dominated on the upper slope, red maple at midslope, and northern red oak and witch hazel on the lower slope.

Bluestone River (Tables 15 and 16)—Diversity of both saplings and seedlings was lowest on the lower slope. Dogwood saplings dominated on the upper slope, ironwood (*Carpinus caroliniana*) at midslope, and sugar maple on the lower slope. In contrast, sassafras, black oak, and mockernut (*Carya tomentosa*) seedlings were about equally abundant on the upper slope.

Shagbark hickory (*C. ovata*) seedlings dominated at midslope, and only beech (*Fagus grandifolia*) and American chestnut (*Castanea dentata*) were tallied as seedlings on the lower slope.

New River (Tables 17 and 18)—Diversity of saplings and seedlings were nearly equal along the range of elevation sampled. Red maple, black gum, and sassafras were the most abundant saplings on the upper slope, whereas black gum and witch hazel dominated at midslope. On the lower slope, sugar maple and pawpaw (*Asimina triloba*) saplings were most numerous. Seedling dominants along the gradient were nearly the same as that of saplings except that sassafras and red maple were most abundant at midslope.

Herbaceous Flora

A complete listing of herbaceous plant taxa observed within and near the study sites and the importance values for the herbaceous taxa sampled will be provided in a separate and follow-up report that will be submitted to the N.S. in the near future. Provided with the current report, however, is a list of herbaceous plant species commonly encountered during the study (**Table 10**).

Soils

Gauley River (Tables 20 and 21) —At Carnifex Ferry State Park, pH values displayed no particular trend along the slope gradient, although the highest values of pH, calcium, magnesium, phosphorus, potassium, manganese, zinc, soluble salts, and nitrogen were found at the lower slope position. This increase in soil nutrient levels, which was generally found along all transects, was expected as soil fertility is generally higher on lower slopes. By contrast, aluminum concentrations were greatest at the upper slope position which is also a predictable condition. Values of all soil factors at Koontz Bend were comparable to those found at Carnifex Ferry.

Bluestone River (Table 22)—At Pipestem State Park, pH values were generally high (compared to the other sites) and tended to increase down slope, as did calcium and magnesium values. Aluminum values were somewhat higher at the upper slope positions. The reason for the

comparatively high pH values was could not be ascertained in this study. Among the factors that could influence pH values include parent material, vegetative cover, and past land uses. In this case, it is likely to be related to parent material.

New River (Table 23)—Values of pH, calcium, magnesium, phosphorus, potassium, manganese, zinc, soluble salts, and nitrogen tended to increase toward lower slope positions (in a manner similar to the Carnifex Ferry site). Aluminum values tended to be highest at sites near the top of the slope.

Tree Ages

Diameters and ages of trees cored at all sample sites are cited in **Tables 24, 25, 26, 27, 28, 29, and 30**. Only the number of the rings was determined. Ascertaining tree ring chronologies exceeded the capacity of this study. Determining such aspects as fire frequencies and growth patterns are possible, but would require additional time and cores; in some instances, felling trees . to obtain cross sections would be helpful (Arno and Sneek, 1977; Baisan and Swetnam, 1990).

SIGNIFICANCE OF FINDINGS

The data collected along the three transects (plus localized sampling in areas that appeared to have old-growth trees) comprise a relatively small data set, which limits the conclusions that can be ascertained from the study. However, the areas studied, both along the transects and at individual sample sites elsewhere, are thought to have provided a good representation of the vegetation diversity and patterns that are common in the gorges. The results, though, do not capture a comprehensive representation of the total diversity of habitats and plant communities that exists in the gorges.

Even with limited data on which to draw conclusions, there are several broad statements that can be made based on our findings:

1. Moisture gradients (moisture availability) as related to slope aspect and direction, appears to exert a strong influence on species distributions and plant community development.
2. While geology has undoubtedly exerted an influence over present vegetation patterns in the three gorges, observations along the transects and elsewhere did not reveal an ostensible correlation between the distribution of a plant species and habitats with a particular rock stratum.
3. Old-growth forests, or at least the occurrence of old individual trees, likely occur elsewhere in the gorges. The old-growth stand sampled at Carnifex Ferry State Park was known before the study, but the other sites—the midslope stand isolated between two rock outcrops on Pipestem State Park; the stand isolated between the railroad, Gauley River, and rock outcrop at Koontz Bend; and the individual tree sampled found on a rock outcrop at the top of the New River Gorge—were all new discoveries. Several trees at these sites exceeded 200 years old. Noteworthy is a red cedar tree, which exceeded 175 years old, discovered on a rock escarpment near the Peregrin Falcon hacking site at the top of the New River Gorge.

Additional searches along other rock outcrops in the gorges may yield specimens older than this one, as described by Larsen and Kelly (1991) and in personal communication with Larsen.

4. Vegetational patterns within the gorges are predictable-dry, oak-dominated forests occur on upper slopes and mesophytic forests occur on lower slopes and in coves. The assemblages of species are also comparable to many of the plant groups described by Oxley (1975) and Sturm (1977) and were consistent with the species listings reported by Grafton (1993); they were also diverse enough to indicate some overlap with those described by Stephenson et al. (1993) for Appalachian Oak Forests.
5. The one small individual of Arbor vitae (*Thuja occidentalis*) reported by Norris (1992b) in the Bluestone River Gorge is evidence that additional individuals of this species could occur elsewhere in this gorge and in the others as well. This is a reasonable assumption given the limited extent to which the gorges have been studied. Individuals of this species, like red cedar, can be relatively long-lived (> 500 years). Proper studies of old-aged individuals could be important in understanding natural fire histories and recent climatic patterns during the past several centuries.

RECOMMENDATIONS

Needless to say, our reconnaissance study confirms that the rugged topography of the three gorges (four, including the Meadow River Gorge) restricts access and makes vegetation sampling more time consuming and difficult than in less steep terrain. Rock escarpments along the rims and on the sides of the gorges were, indeed, barriers that limited access to many potential study sites. For these reasons, we recommend that future vegetational studies focus separately on an individual gorge. Studying one at a time would permit timely reporting of findings and more thorough coverage of a particular gorge. Further, with adequate air photo coverage, a detailed vegetation map could be completed on each gorge, using the field collection sites as "ground truthing" stations..

If a vegetation study can be initiated during the 1995 field season, we recommend the Bluestone River Gorge for the following reasons:

- 1) Current color infrared aerial photography already exists for this area, making the production of a vegetation map of the gorge possible without funding additional photography.
- 2) Based on casual observations in the Bluestone River Gorge region, red cedar appears more common than in the New, Gauley, and Meadow River Gorges. For this reason, chances may be greatest of finding old-aged red cedar there. Norris (1992) also found northern atlantic white cedar in the Bluestone Gorge. Red cedar and northern white cedar are the longest-lived tree species in the East.
- 3) The Sturm and Oxley studies would serve as good reference studies for additional vegetation investigations.
- 4) The Bluestone River Gorge is a multiple use area. Within the Gorge are the Bluestone Scenic River, Pipestem and Bluestone State Parks, and Bluestone Wildlife Management Area. Agencies with management authority within the Gorge are the National Park Service (N.S.), U.S. Army Corps of Engineers

(COE), and the Wildlife Resources and State Park Sections of the West Virginia Division of Natural Resources (DNR). Each of these agencies could benefit from further ecological studies within the Gorge, and each agency may be willing to cost share a more detailed vegetation study.

Table 1. General characteristics of stands studied at Carnifex Ferry State Park on the Gauley River on 16-17 July 1994.

PARAMETER	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
Elevation (ft)	1640	1570	1370
Aspect (°)	115-150	198-210	142-190
Inclination (%)	6-10	14-15	16-18
Tree Ages (No. Rings) ¹	84-306	75-204	31-43
Richness (No. spp.) ²	10	8	9
Shannon Index (H') ²	1.934	1.830	1.803
Tree Density (N/ha) ²	490	470	440
Basal Area (m ² /ha) ²	33.6	40.5	21.4
Small Tree Density (N/ha) ³	460	550	530
Basal Area (m ² /ha) ³	1.2	1.7	1.3
Sapling Density (N/ha) ⁴	350	290	700
Seedling Density (N/ha) ⁵	9,900	1,200	1,000
Shrub Density (N/ha) ⁶	1,500	4,300	19,100

¹Trees cored at breast height (1.37 m above ground level); n = 5 each stand

²Trees(>10.0cmDBH)

³Trees (2.5-9.9 cm DBH)

⁴Tree stems (<2.5 cm DBH but > 1 m tall)

⁵Tree stems (<1 m tall)

⁶Includes vines

Table 2. General characteristics of stands studied at Koontz Bend on the Gauley River on 22 October 1994.

PARAMETER	STAND 1	STAND 2
Elevation (ft)	1100	1100
Aspect (°)	320	335
Inclination (%)	70	22
Tree Ages (No. Rings) ¹	43-222	82-161
Tree Density (N/ha) ²	360	480
Basal Area (m ² /ha) ²	33.3	33.7
Small Tree Density (N/ha) ³	40	340
Basal Area (m ² /ha) ³	<0.1	0.9

¹Trees cored at breast height (1.37 m above ground level); n = 4-6 each plot

²Trees(>10.0cmDBH)

³Trees (2.5-9.9 cm DBH)

⁴Tree stems (<2.5 cm DBH but > 1 m tall)

⁵Tree stems (<1 m tall)

Table 3. General characteristics of stands studied at Pipestem State Park on the Bluestone River on 16-17 July 1994.

PARAMETER	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
Elevation (ft)	2200	1900	1570
Aspect (°)	210-248	240-260	260-285
Inclination (%)	15-20	27-31	25-35
Tree Ages (No. Rings) ¹	44-137	68-278	87-144
Richness (No. spp.) ²	11	6	10
Shannon Index (H') ²	2.011	1.423	2.095
Tree Density (N/ha) ²	490	280	200
Basal Area (m ² /ha) ²	24.9	19.4	17.5
Small Tree Density (N/ha) ³	840	1,210	2,490
Basal Area (m ² /ha) ³	1.5	1.9	3.8
Sapling Density (N/ha) ⁴	970	2,560	2,730
Seedling Density (N/ha) ⁵	3,200	1,600	200
Shrub Density (N/ha) ⁶	3,900	3,800	800

¹Trees cored at breast height (1.37 m above ground level); n = 5 each stand

²Trees(>10.0cmDBH)

³Trees (2.5-9.9 cm DBH)

⁴Tree stems (<2.5 cm DBH but > 1 m tall)

⁵Tree stems (<1 m tall)

⁶Includes vines

Table 4. General characteristics of stands studied on the New River on 16-17 July 1994.

PARAMETER	UPPER SLOPE	UPPER MID	MIDSLOPE	LOWER MID	LOWER SLOPE
Elevation (ft)	1810	1610	1410	1210	980
Aspect (°)	130	170	170	165	180
Inclination (%)	12	36	25	22	15
Tree Ages (No. Rings) ¹	48-119 ³	48-52 ^b	29-54 ^a	38-50"	46-96 ^a
Richness (No. spp.) ²	11	6	10	8	11
Shannon Index (H') ²	1.984	1.191	1.852	1.785	2.093
Tree Density (N/ha) ²	330	575	340	500	290
Basal Area (m ² /ha) ²	19.1	17.2	17.8	32.6	25.4
Small Tree Density (N/ha) ³	1,700	875	1,190	375	600
Basal Area (m ² /ha) ³	4.8	2.2	1.5	1.1	1.2
Sapling Density (N/ha) ⁴	1,510	2,050	3,750	1,775	1,820
Seedling Density (N/ha) ⁵	22,000	NO DATA	6,600	NO DATA	5,600
Shrub Density (N/ha) ⁶	13,600	NO DATA	17,900	NO DATA	16,200

¹Trees cored at breast height (1.37 m above ground level); n = 5 each stand" or 3 each stand^b

²Trees(>10.0cmDBH)

³Trees (2.5-9.9 cm DBH)

⁴Tree stems (<2.5 cm DBH but > 1 m tall)

⁵Tree stems (<1 m tall)

⁶Includes vines

Table 5. Importance values (relative density + relative basal area/2) for trees (> 10 cm DBH) located at Carnifex Ferry State Park on the Gauley River. Data collected on 16-17 July 1994.

SPECIES	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
<i>Tsuga canadensis</i>	38.4	33.1	5.6
<i>Acer rubrum</i>	12.6	10.8	2.0
<i>Nyssa sylvatica</i>	11.6	7.4	—
<i>Quercus alba</i>	11.5	19.3	—
<i>Acer saccharum</i>	6.4	1.4	—
<i>Liriodendron tulipifera</i>	5.1	—	16.4
<i>Quercus velutina</i>	4.2	—	—
<i>Oxydendrum arboreum</i>	4.0	—	2.1
<i>Fagus grandifolia</i>	3.3	—	—
<i>Carya glabra</i>	3.0	—	—
<i>Quercus rubra</i>	—	12.5	29.0
<i>Magnolia fraseri</i>	—	9.3	3.6
<i>Quercus prinus</i>	—	6.3	1.6
<i>Betula lutea</i>	—	—	21.3
<i>B. lenta</i>	—	—	18.5

Table 6. Importance values (relative density + relative basal area/2) for trees (> 10 cm dbh) located at Koontz Bend on the Gauley River. Data collected on 22 October 1994.

SPECIES	STAND 1	STAND 2
<i>Tsuga canadensis</i>	68.6	42.0
<i>Acer rubrum</i>	23.0	—
<i>Nyssa sylvatica</i>	8.4	—
<i>Liriodendron tulipifera</i>	—	18.6
<i>Fagus grandifolia</i>	—	15.4
<i>Betula lenta</i>	—	15.4
<i>Juglans cinerea</i>	—	4.9
<i>Prunus serotina</i>	—	3.7

Table 7. Importance values (relative density + relative basal area/2) for trees (> 10 cm dbh) located at Pipestem State Park on the Bluestone River. Data collected on 16-17 July 1994.

SPECIES	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
<i>Quercus alba</i>	37.8	30.6	5.3
<i>Acer saccharum</i>	11.5	4.4	2.8
<i>Aesculus octandra</i>	11.4	—	—
<i>Quercus velutina</i>	8.8	—	—
<i>Q. rubra</i>	7.3	24.7	17.2
<i>Liriodendron tulipifera</i>	5.5	—	—
<i>Carya ovata</i>	4.6	3.0	8.7
<i>C. glabra</i>	3.9	3.0	7.0
<i>Prunus serotina</i>	3.9	—	—
<i>Carya tomentosa</i>	3.7	—	7.9
<i>Quercus prinus</i>	1.6	34.3	7.6
<i>Fraxinus sp.</i>	—	—	16.0
<i>Robinia pseudoacacia</i>	—	—	2.9
<i>Pinus strobus</i>	—	—	24.5

Table 8. Importance values (relative density + relative basal area/2) for trees (> 10 cm dbh) located on the New River. Data collected on 16-17 July 1994.

SPECIES	UPPER SLOPE	UPPER MID	MIDSLOPE	LOWER MID	LOWER SLOPE
<i>Quercm prinus</i>	35.0	63.3	7.1	...	—
<i>Q. velutina</i>	22.2	15.6	—	...	10.0
<i>Oxydendrum arboreum</i>	7.0	6.2	—	3.8	—
<i>Quercus rubra</i>	6.1	5.9	8.2	—	24.9
<i>Pinus rigida</i>	5.6	—	...	—	—
<i>Acer rubrum</i>	5.5	6.2	1.8	3.1	—
<i>Carya glabra</i>	4.6	2.8	32.4	17.6	10.6
<i>Quercus alba</i>	4.5	—	12.9	—	8.7
<i>Liriodendron tulipifera</i>	4.0	—	25.8	33.5	—
<i>Robinia pseudoacacia</i>	3.7	—	4.2	18.8	—
<i>Nyssa sylvatica</i>	1.8	—	1.8	—	...
<i>Acer saccharum</i>	—	—	1.8	10.1	21.8
<i>Carya tomentosa</i>	—	—	4.1	—	...
<i>Fraxinus sp.</i>	...	—	—	10.1	9.2
<i>Sassafras albidum</i>	—	—	—	2.9	—
<i>Asimina triloba</i>	—	—	...	—	2.0
<i>Carya cordiformis</i>	—	—	—	—	4.4
<i>C. ovata</i>	—	—	—	...	4.2
<i>Cercis canadensis</i>	—	—	—	—	2.0
<i>Tilia heterophylla</i>	—	—	—	—	2.4

Table 9. Importance values (relative density + relative basal area/2) for small trees (2.5-9.9 cm dbh) located at Carnifex Ferry State Park on the Gauley River. Data collected on 16-17 July 1994.

SPECIES	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
<i>Tsuga canadensis</i>	46.2	90.3	3.2
<i>Acer rubrum</i>	10.2	1.2	5.0
<i>Ilex opaca</i>	2.5	—	—
<i>Acer pensylvanicum</i>	3.7	—	—
<i>A. saccharum</i>	9.5	—	—
<i>Cornus florida</i>	5.6	—	5.5
<i>Quercus velutina</i>		1.5	...
<i>Oxydendrum arboreum</i>	5.5	—	3.5
<i>Fagus grandifolia</i>	7.5	—	—
<i>Quercus rubra</i>	—	1.2	—
<i>Magnolia fraseri</i>	7.0	1.9	—
<i>Quercus prinus</i>	—	2.7	—
<i>Betula lutea</i>	—	—	33.6
<i>B. lenta</i>	2.2	—	7.1
<i>Prunus serotina</i>	—	1.3	—
<i>Hamamelis virginiana</i>	—	—	33.4
<i>Carya tomentosa</i>	—	—	5.8
<i>Cornus alternifolia</i>	—	—	1.5
<i>Fraxinus pennsylvanica</i>	—	—	1.4

Table 10 . Importance values (relative density + relative basal area/2) for small trees (2.5-9.9 cm dbh) located at Koontz Bend on the Gauley River. Data collected on 22 October 1994.

SPECIES	STAND 1	STAND 2
<i>Tsuga canadensis</i>	100.0	47.2
<i>Acer saccharum</i>	—	22.5
<i>Fagus grandifolia</i>	—	18.4
<i>Acer rubrum</i>	—	11.2

Table 11. Importance values (relative density + relative basal area/2) for small trees (2.5-9.9 cm dbh) located at Pipestem State Park on the Bluestone River. Data collected on 16-17 July 1994.

SPECIES	UPPER SLOPE	MEDSLOPE	LOWER SLOPE
<i>Quercus alba</i>	7.8	2.9	—
<i>Acer saccharum</i>	25.9	29.2	52.1
<i>Aesculus octandra</i>	0.8	—	0.9
<i>Cornus florida</i>	23.1	5.2	5.5
<i>Q. rubra</i>	—	16.5	2.0
<i>Ostrya virginiana</i>	12.4	2.3	7.3
<i>Carya ovata</i>	0.9	1.1	0.7
<i>C. glabra</i>	—	6.8	1.1
<i>Prunus serotina</i>	2.4	—	—
<i>Carya tomentosa</i>	1.1	2.0	0.7
<i>Quercus prinus</i>	2.4	12.1	0.3
<i>Fraxinus sp.</i>	4.7	2.6	9.6
<i>Robinia pseudoacacia</i>	—	7.3	2.3
<i>Fagus grandifolia</i>	0.8	—	9.0
<i>Acer rubrum</i>	12.9	—	—
<i>Amelanchier arborea</i>	0.8	4.8	1.1
<i>Sassafras albidum</i>	2.3	—	
<i>Tilia heterophylla</i>	—	—	6.3
<i>Cercis canadensis</i>	1.5	7.3	1.1

Table 12. Importance values (relative density + relative basal area/2) for small trees (2.5-9.9 cm dbh) located on the New River. Data collected on 16-17 July 1994.

SPECIES	UPPER SLOPE	UPPER MID	MIDSLOPE	LOWE R MID	LOWER SLOPE
<i>Quercus prinus</i>	5.5	29.0	1.3	—	—
<i>Q. velutina</i>	8.0	10.0	3.1	—	—
<i>Oxydendrum arboreum</i>	24.9	19.3	5.3	—	—
<i>Quercus rubra</i>	1.7	—	2.0	—	—
<i>Cornus florida</i>	8.9	—	4.2	—	—
<i>Acer rubrum</i>	15.2	7.4	15.3	—	—
<i>Carya glabra</i>	1.5	25.4	5.0	—	2.1
<i>Quercus alba</i>	3.0	—	0.6	6.0	—
<i>Liriodendron tulipifera</i>	2.9	—	1.9	—	—
<i>Robinia pseudoacacia</i>	1.6	1.9	—	—	—
<i>Nyssa sylvatica</i>	11.7	6.9	17.0	—	—
<i>Acer saccharum</i>	—	—	5.9	68.5	78.3
<i>Carya tomentosa</i>	0.4	—	8.5	...	—
<i>Fraxinus sp.</i>	—	—	3.7	4.2	—
<i>Sassafras albidum</i>	14.0	—	15.3	—	—
<i>Aralia spinosa</i>	0.9	—	—	—	—
<i>Asimina triloba</i>	—	—	—	—	18.1
<i>Carya cordiformis</i>	—	—	—	7.3	—
<i>C. ovata</i>	—	—	—	—	—
<i>Cercis canadensis</i>	—	—	1.2	4.1	—
<i>Hamamelis virginiana</i>	—	—	7.5	—	—
<i>Ulmus rubra</i>	—	—	1.5	—	—
<i>Prunus serotina</i>	—	—	0.6	—	—
<i>Quercus muehlenbergii</i>	—	—	—	10.0	—
<i>Tilia heterophylla</i>	—	—	—	—	1.5

Table 13. Density (N/ha) of tree saplings (individuals <2.5 cm DBH but > 1 m tall) located at Carnifex Ferry State Park on the Gauley River. Data collected on 16-17 July 1994.

SPECIES	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
<i>Tsuga canadensis</i>	260	240	20
<i>Acer rubrum</i>	50		60
<i>Nyssa sylvatica</i>	—	20	—
<i>Acer pensylvanicum</i>	—	—	100
<i>Castanea dentata</i>	—	—	10
<i>Corylus sp.</i>	—	—	10
<i>Quercus velutina</i>	—	10	—
<i>Oxydendrum arboreum</i>	—	—	40
<i>Fagus grandifolia</i>	30	—	—
<i>Quercus rubra</i>	—	—	30
<i>Magnolia fraseri</i>	10	20	—
<i>Betula lutea</i>	—	—	40
<i>Hamamelis virginiana</i>	—	—	360
<i>Cornus alternifolia</i>	—	—	10
<i>Fraxinus pennsylvanica</i>	—	—	20
TOTAL	350	290	700

Table 14. Density (N/ha) of tree saplings (individuals < 1m tall) located at Carnifex Ferry State Park on the Gauley River. Data collected on 16-17 July 1994.

SPECIES	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
<i>Tsuga canadensis</i>	200	200	—
<i>Acer rubrum</i>	—	500	—
<i>Acer pensylvanicum</i>	7,200	—	—
<i>Oxydendrum arboreum</i>	200	—	100
<i>Quercus rubra</i>	1,800	—	400
<i>Magnolia fraseri</i>	100	100	—
<i>Betula lutea</i>	—	—	100
<i>Hamamelis virginiana</i>	—	—	300
<i>Prunus serotina</i>	400	—	—
<i>Quercus prinus</i>	—	100	—
<i>Ilex opaca</i>	—	200	—
<i>Liriodendron Tulipifera</i>	—	100	—
<i>Corya sp.</i>	—	—	100
TOTAL	9,900	1,200	1,000

Table 15. Density (N/ha) of tree saplings (individuals <2.5 cm DBH but > 1 m tall) located at Pipestem State Park on the Bluestone River. Data collected on 16-17 July 1994.

SPECIES	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
<i>Quercus alba</i>	10	110	—
<i>Acer saccharum</i>	130	320	1,850
<i>Aesculus octandra</i>	60	10	90
<i>Cornus florida</i>	250	540	110
<i>Q. rubra</i>	10	70	—
<i>Ostrya virginiana</i>	170	910	300
<i>Carya ovata</i>	—	60	—
<i>C. glabra</i>	—	70	—
<i>Prunus serotina</i>	10	—	—
<i>Carya tomentosa</i>	40	80	10
<i>Quercus prinus</i>	—	40	20
<i>Fraxinus sp.</i>	20	50	50
<i>Robinia pseudoacacia</i>	—	20	—
<i>Fagus grandifolia</i>	70	—	250
<i>Acer rubrum</i>	80	—	—
<i>Amelanchier arborea</i>	70	110	40
<i>Sassafras albidum</i>	—	10	—
<i>Nyssa sylvatica</i>	10	—	—
<i>Cercis canadensis</i>	10	140	—
<i>Quercus velutina</i>	10	—	—
<i>Pinus strobus</i>	20	20	—
<i>Hamamelis virginiana</i>	—	—	10
TOTAL	970	2,560	2,730

Table 16. Density (N/ha) of tree seedlings (individuals <1 m tall) located at Pipestem State Park on the Bluestone River. Data collected on 16-17 July 1994.

SPECIES	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
<i>Quercus alba</i>	200	—	—
<i>Acer saccharum</i>	100	—	—
<i>Aesculus octandra</i>	200	—	—
<i>Cornus florida</i>	100	100	—
<i>Q. rubra</i>	—	100	—
<i>Ostrya virginiana</i>	100	100	—
<i>Carya ovata</i>	—	500	—
<i>Carya tomentosa</i>	600	—	—
<i>Quercus prinus</i>	100	200	—
<i>Fraxinus sp.</i>	—	100	—
<i>Robinia pseudoacacia</i>	—	100	—
<i>Fagus grandifolia</i>	—	—	100
<i>Sassafras albidum</i>	700	—	—
<i>Cercis canadensis</i>	200	300	—
<i>Quercus velutina</i>	700	100	—
<i>Tsuga canadensis</i>	100	—	—
<i>Castanea dentata</i>	—	—	100
<i>Pinus strobus</i>	100	—	—
TOTAL	3,200	1,600	200

Table 17. Density (N/ha) of tree saplings (individuals <2.5 cm DBH but a 1 m tall) located on the New River. Data collected on 16-17 July 1994.

SPECIES	UPPER SLOPE	UPPER MID	MIDSLOPE	LOWER MID	LOWER SLOPE
<i>Quercus prinus</i>	—	375	150	—	10
<i>Q. velutina</i>	20	150	70	25	—
<i>Oxydendrum arboreum</i>	90	—	—	25	—
<i>Quercus rubra</i>	—	75	70	50	—
<i>Cornus florida</i>	130	—	20	—	—
<i>Acer rubrum</i>	340	75	250	—	60
<i>Garya glabra</i>	100	475	150	25	60
<i>Quercus alba</i>	10	—	100	—	—
<i>Liriodendron tulipifera</i>	70	—	—	—	—
<i>Robinia pseudoacacia</i>	—	175	20	—	—
<i>Nyssa sylvatica</i>	320	75	1,320	—	—
<i>Acer saccharum</i>	—	—	40	1,125	940
<i>Carya tomentosa</i>	.10	—	100	—	—
<i>Fraxinus sp.</i>	—	—	70	125	30
<i>Sassafras albidum</i>	330	425	330	—	—
<i>Aralia spinosa</i>	60	—	—	—	—
<i>Asimina triloba</i>	—	—	—	—	600
<i>Carya cordiformis</i>	—	—	—	25	60
<i>Ilex opaca</i>	10	—	—	—	—
<i>Cercis canadensis</i>	—	—	30	175	—
<i>Hamamelis virginiana</i>	—	—	940	—	—
<i>Ulmus rubra</i>	—	50	40	25	20
<i>Prunus serotina</i>	—	...	20	—	...
<i>Quercus muehlenbergii</i>	—	—	—	175	...
<i>Amelanchier arborea</i>	—	125	10	—	—
<i>Pinus rigida</i>	—	50	—	—	—
<i>Celtis occidentalis</i>	—	—	20	—	10
<i>Castanea dentata</i>	20	—	—	—	—
<i>Fagus grandifolia</i>	—	—	—	—	10
TOTAL	1,510	2,050	3,750	1,775	1,820

Table 18. Density (N/ha) of tree seedlings (individuals <1 m tall) located on the New River. Data collected on 16-17 July 1994.

SPECIES	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
<i>Quercus prinus</i>	2,200	—	—
<i>Q. velutina</i>	300	200	—
<i>Oxydendrum arboreum</i>	200	300	—
<i>Quercus rubra</i>	200	300	100
<i>Cornus florida</i>	200	—	—
<i>Acer rubrum</i>	2,600	1,500	100
<i>Carya glabra</i>	—	200	100
<i>Quercus alba</i>	—	100	100
<i>Liriodendron tulipifera</i>	800	100	—
<i>Nyssa sylvatica</i>	4,400	600	—
<i>Acer saccharum</i>	—	—	3,000
<i>Carya tomentosa</i>	1,000	—	—
<i>Fraxinus sp.</i>	—	600	200
<i>Sassafras albidum</i>	9,500	2,000	—
<i>Aralia spinosa</i>	300	—	—
<i>Asimina triloba</i>	—	—	200
<i>Carya cordiformis</i>	—	200	900
<i>Hamamelis virginiana</i>	—	400	—
<i>Ulmus rubra</i>	—	—	500
<i>Prunus serotina</i>	—	100	100
<i>Celtis occidentalis</i>	—	—	300
<i>Castanea dentata</i>	300	—	—
TOTAL	22,000	6,600	5,600

Table 19. Common herbaceous species observed in the Gauley, Bluestone, and New River Gorges.

PLANT SPECIES	PLANT SPECIES
Laportea canadensis	Viola rotundifolia
Stellaria pubera	Dentaria diphylla
Sedum ternatum	Thalictrum dioica
Aster divaricatus	Carex laxiflorus
Solidago caesia	Dryopteris marginalis
Potentilla simplex	Dryopteris intermedia
Apios americana	Polypodium virginianum
Collinsonia canadensis	Chimaphila maculata
Smilacina racemosa	Geranium maculatum
Panicum boscii	Dioscorea quadifolia
Geum canadense	Polystrichum acrostichoides
Prenathes alba	Erythronium americanum
Galium pilosa	Cirsium vulgare
Dioscorea villosa	Asplenium ebenoides

Table 20. Soil chemical characteristics for the elevational transect at Carnifex Ferry State Park on the Gauley River. Samples collected 16-17 July 1994.

PARAMETER	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
pH	3.7	3.3	4.2
Ca (ppm)	120	146	721
Mg (ppm)	28	29	109
P (ppm)	3	4	30
K (ppm)	39	54	115
Mn (ppm)	36	20	232
Zn (ppm)	2	3	11
Fe (ppm)	68	80	13
Al (ppm)	401	251	52
Cu (ppm)	0.3	0.3	0.1
B (ppm)	0.1	0.1	0.2
SS (ppm)	154	282	358
N (ppm)	3	3	18
OM (%)	9	≥15	≥15

Table 21. Soil chemical characteristics for the elevational transect at Pipestem State Park on the Bluestone River. Samples collected 16-17 July 1994.

PARAMETER	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
PH	5.0	5.3	6.0
Ca (ppm)	943	1014	1822
Mg (ppm)	110	113	128
P (ppm)	4	2	9
K (ppm)	80	75	64
Mn (ppm)	58	68	53
Zn (ppm)	2	2	2
Fe (ppm)	31	25	8
Al (ppm)	181	191	110
Cu (ppm)	0.2	0.2	0.2
B (ppm)	0.3	0.2	0.5
SS (ppm)	115	90	128
N (ppm)	5	3	8
OM (%)	10	5	6

Table 22. Soil chemical characteristics for the elevational transect at Pipestem State Park on the Bluestone River. Samples collected 16-17 July 1994.

PARAMETER	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
pH	5.0	5.3	6.0
Ca (ppm)	943	1014	1822
Mg (ppm)	110	113	128
P (ppm)	4	2	9
K (ppm)	80	75	64
Mn (ppm)	58	68	53
Zn (ppm)	2	2	2
Fe (ppm)	31	25	8
Al (ppm)	181	191	110
Cu (ppm)	0.2	0.2	0.2
B (ppm)	0.3	0.2	0.5
SS (ppm)	115	90	128
N (ppm)	5	3	8
OM (%)	10	5	6

Table 23. Soil chemical characteristics for the elevational transect along the New River gorge. Samples collected 16-17 July 1994.

PARAMETER	UPPER SLOPE	UPPER MID	MIDSLOPE	LOWER MID	LOWER SLOPE
pH	3.8	4.0	4.5	5.4	5.4
Ca (ppm)	53	79	326	1256	1896
Mg (ppm)	15	21	62	141	198
P (ppm)	1	1	1	3	3
K (ppm)	33	63	60	86	129
Mn (ppm)	26	69	89	149	149
Zn (ppm)	2	2	3	5	8
Fe (ppm)	74	81	44	6	8
Al (ppm)	276	374	263	299	196
Cu (ppm)	0.3	0.4	0.6	0.2	0.2
B (ppm)	0.1	0.1	0.1	0.5	0.7
SS(ppm)	115	102	115	192	256
N (ppm)	3	3	3	18	25
OM (%)	5.5	6.5	≥15	11.0	≥15

Table 24 . Diameter (cm) at breast height (1.37 m above ground level) and number of rings counted for trees cored at Carnifex Ferry State Park on the Gauley River (16-17 July 1994).

SPECIES	UPPER SLOPE		MIDSLOPE		LOWER SLOPE	
	DBH	RINGS	DBH	RINGS	DBH	RINGS
<i>Quercus alba</i>	99.6	261	80.1	204	—	—
<i>Q. alba</i>	68.3	154	68.5	194	—	—
<i>Q. alba</i>	87.9	159	74.4	173	—	—
<i>Q. alba</i>	70.1	306	—	—	—	—
<i>Q. velutina</i>	56.9	84	—	—	—	—
<i>Tsuga canadensis</i>	—	—	52.3	75	—	—
<i>T. canadensis</i>	—	—	45.3	86	—	—
<i>Magnolia fraseri</i>	—	—	—	—	22.4	31
<i>Liriodendron tulipifera</i>	—	—	—	—	49.7	31
<i>L. tulipifera</i>	—	—	—	—	40.1	32
<i>Quercus rubra</i>	—	—	—	—	36.2	43

Table 25. Diameter (cm) at breast height (1.37 m above ground level) and number of rings counted for trees cored at Koontz Bend on the Gauley River (22 October 1994).

SPECIES	STAND 1		STAND 2	
	DBH	RINGS	DBH	RINGS
<i>Tsuga canadensis</i>	64.8	222	57.9	120
<i>T. canadensis</i>	58.0	121	49.1	82
<i>T. canadensis</i>	76.0	129	—	—
<i>Quercus rubra</i>	73.6	43	—	...
<i>Acer rubrum</i>	71.5	129	—	—
<i>Magnolia fraseri</i>	28.3	60	—	—
<i>Fagus grandifolia</i>	—	—	58.2	161
<i>F. grandifolia</i>	...	—	62.8	87

Table 26. Diameter (cm) at breast height (1.37 m above ground level) and number of rings counted for trees cored at Pipestem State Park on the Bluestone River (16-17 July 1994).

SPECIES	UPPER SLOPE		MIDSLOPE		LOWER SLOPE	
	DBH	RINGS	DBH	RINGS	DBH	RINGS
<i>Quercus alba</i>	45.2	99	46.7	68	—	—
<i>Q. alba</i>	36.5	64	31.7	131	—	—
<i>Q. alba</i>	43.5	137	—	—	—	—
<i>Aesculus octandra</i>	28.6	66	—	—	—	—
<i>Liriodendron tulipifera</i>	30.8	44	---	—	—	—
<i>Quercus rubra</i>	—	—	37.5	135	70.0	107
<i>Q. rubra</i>	—	—	38.7	138	39.5	122
<i>Q. prinus</i>	—	—	49.1	278	92.4	144
<i>Pinus strobus</i>	—	—	—	—	64.0	114
<i>Tsuga canadensis</i>	—	—	—	—	43.1	87

Table 27. Diameter (cm) at breast height (1.37 m above ground level) and number of rings counted for trees cored on the New River (16-17 July 1994).

SPECIES	UPPER SLOPE		UPPER MID		MIDSLOPE		LOWER MID		LOWER SLOPE	
	DBH	RINGS	DBH	RINGS	DBH	RINGS	DBH	RINGS	DBH	RINGS
<i>Pinus rigida</i>	42.9	99	—	—	—	—	—	—	—	—
<i>Quercus alba</i>	57.3	53	—	—	41.5	54	—	—	65.6	96
<i>Q. alba</i>	48.2	76	—	—	—	—	—	—	—	—
<i>Q. prinus</i>	71.4	119	28.2	52	49.2	51	—	—	—	—
<i>Q. prinus</i>	—	—	25.9	54	—	—	—	—	—	—
<i>Q. prinus</i>	—	—	29.2	48	—	—	—	—	—	—
<i>Q. rubra</i>	54.4	48	—	—	58.3	37	—	—	106.7	60
<i>Q. rubra</i>	—	—	—	—	43.3	53	—	—	—	—
<i>Q. velutina</i>	76.2	70	—	—	—	—	—	—	—	—
<i>Liriodendron tulipifera</i>	—	—	—	—	29.5	29	49.3	50	—	—
<i>L. tulipifera</i>	—	—	—	—	—	—	39.9	38	—	—
<i>L. tulipifera</i>	—	—	—	—	—	—	33.3	38	—	—
<i>Fraxinus americana</i>	—	—	—	—	—	—	—	—	78.0	54
<i>F. americana</i>	—	—	—	—	—	—	—	—	86.8	73
<i>F. americana</i>	—	—	—	—	—	—	—	—	69.4	46

Table 28. Diameter (cm) at breast height (1.37 m above ground level) and number of rings counted for trees cored at the cliff bottom in the gorge along the New River (22 October 1994).

SPECIES	DBH	RINGS
<i>Quercus prinus</i>	60.1	87
<i>Q. prinus</i>	60.2	60
<i>Q. prinus</i>	60.2	46
<i>Q. prinus</i>	39.5	54
<i>Q. prinus</i>	31.7	45
<i>Q. prinus</i>	50.1	72
<i>Q. prinus</i>	72.6	60
<i>Q. prinus</i>	42.1	59
<i>Q. prinus</i>	70.4	85
<i>Q. prinus</i>	58.3	94
<i>Q. prinus</i>	47.5	76
<i>Q. prinus</i>	91.3	71
<i>Q. alba</i>	47.6	58
<i>Q. alba</i>	53.2	59
<i>Tsuga canadensis</i>	85.4	121

Table 29. Diameter (cm) at breast height (1.37 m above ground level) and number of rings counted for additional trees cored at the cliff edge in the gorge along the New River (15 December 1994).

SPECIES	DBH	RINGS
<i>Juniperus virginiana</i>	27.4	186
<i>J. virginiana</i>	4.2	19
<i>Quercus velutina</i>	61.2	110
<i>Pinus rigida</i>	52.2	49

Table 30. Diameter (cm) at breast height (1.37 m above ground level) and number of rings counted for trees cored at the cliff edge in the gorge along the Meadow River (15 December 1994).

SPECIES	DBH	RINGS
<i>Pinus virginiana</i>	25.4	94
<i>P. virginiana</i>	15.3	47

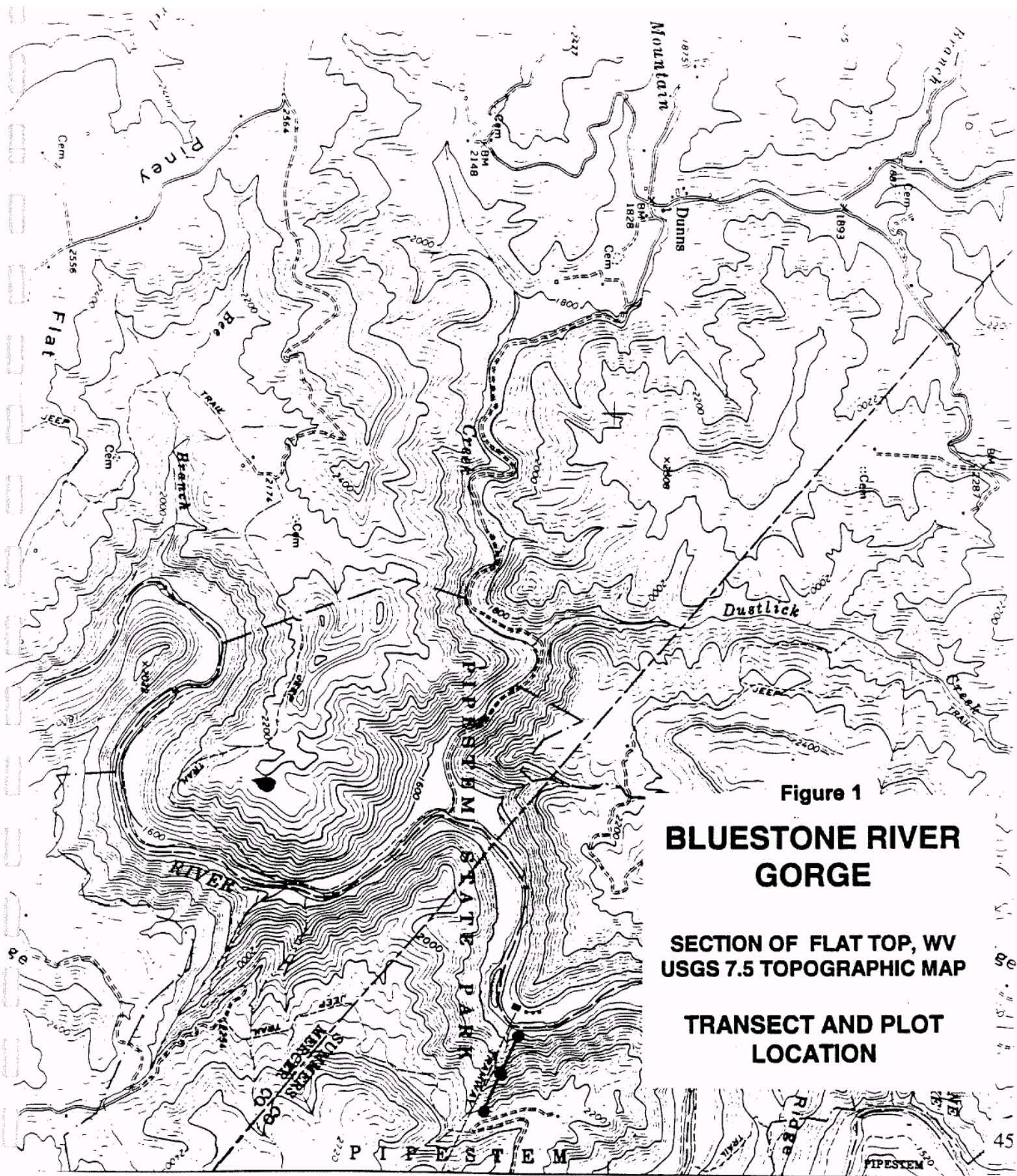
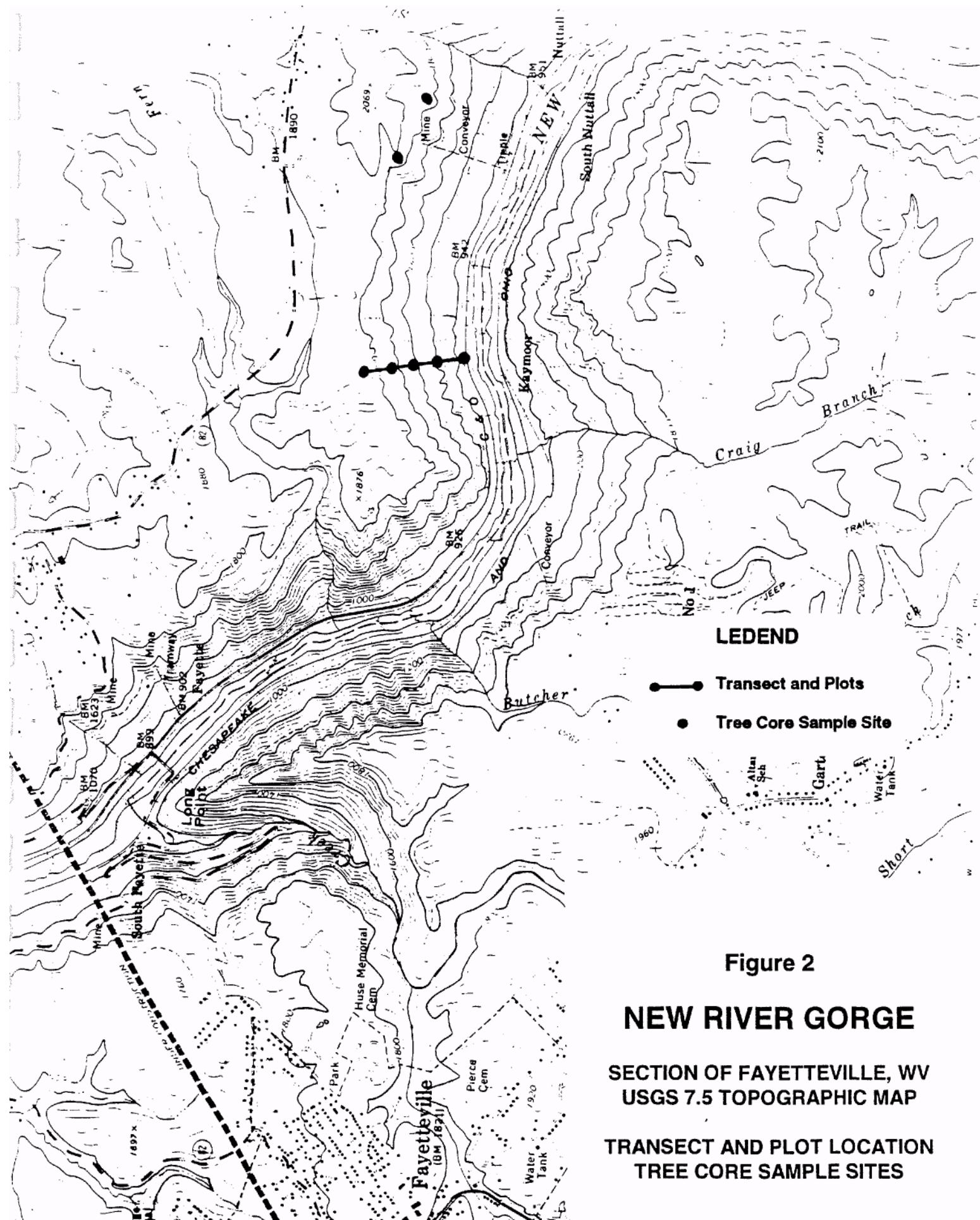


Figure 1

BLUESTONE RIVER GORGE

SECTION OF FLAT TOP, WV
USGS 7.5 TOPOGRAPHIC MAP

TRANSECT AND PLOT
LOCATION



LEDEND

- Transect and Plots
- Tree Core Sample Site

Figure 2

NEW RIVER GORGE

SECTION OF FAYETTEVILLE, WV
USGS 7.5 TOPOGRAPHIC MAP

TRANSECT AND PLOT LOCATION
TREE CORE SAMPLE SITES

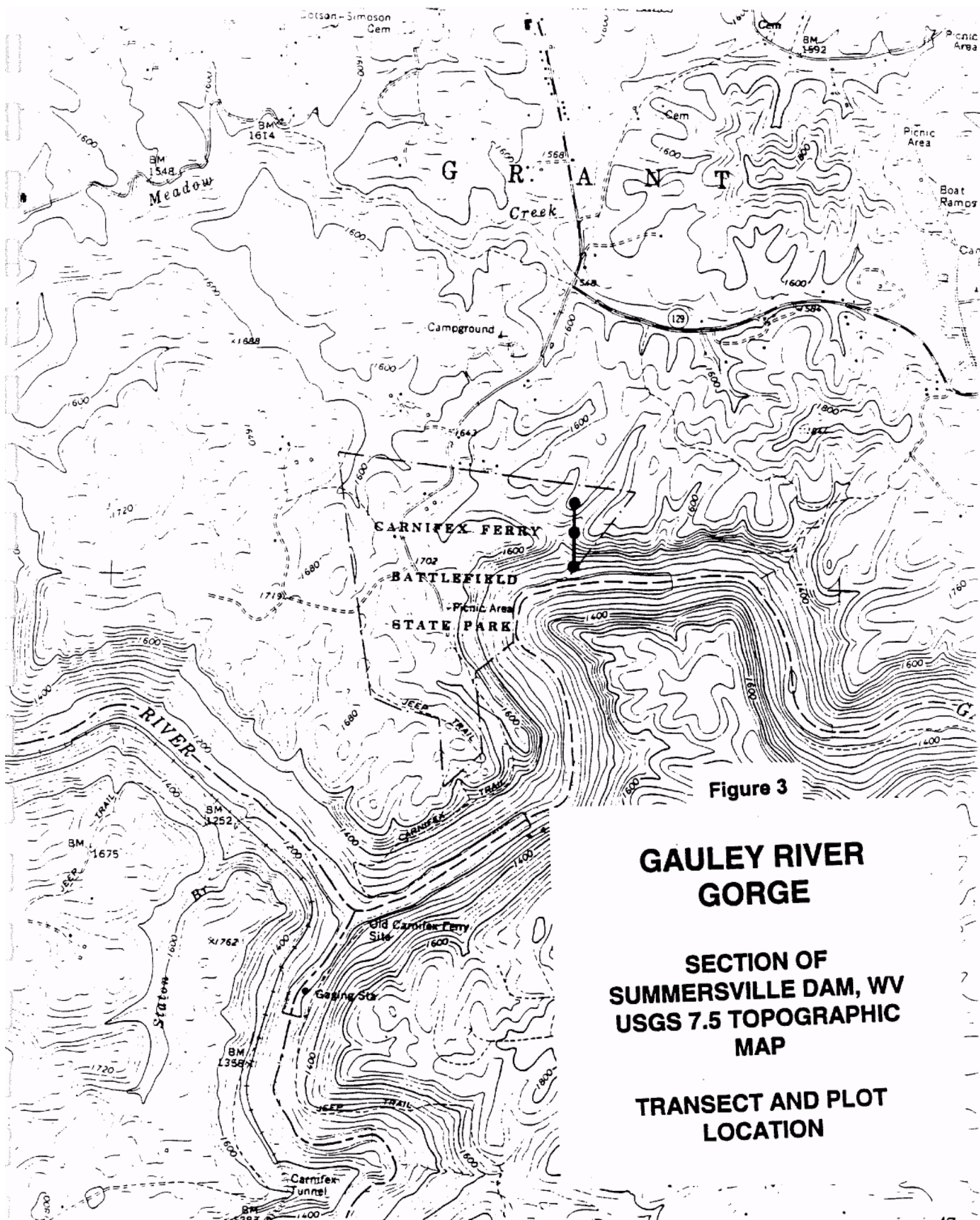


Figure 3

GAULEY RIVER GORGE

SECTION OF
SUMMERSVILLE DAM, WV
USGS 7.5 TOPOGRAPHIC
MAP

TRANSECT AND PLOT
LOCATION

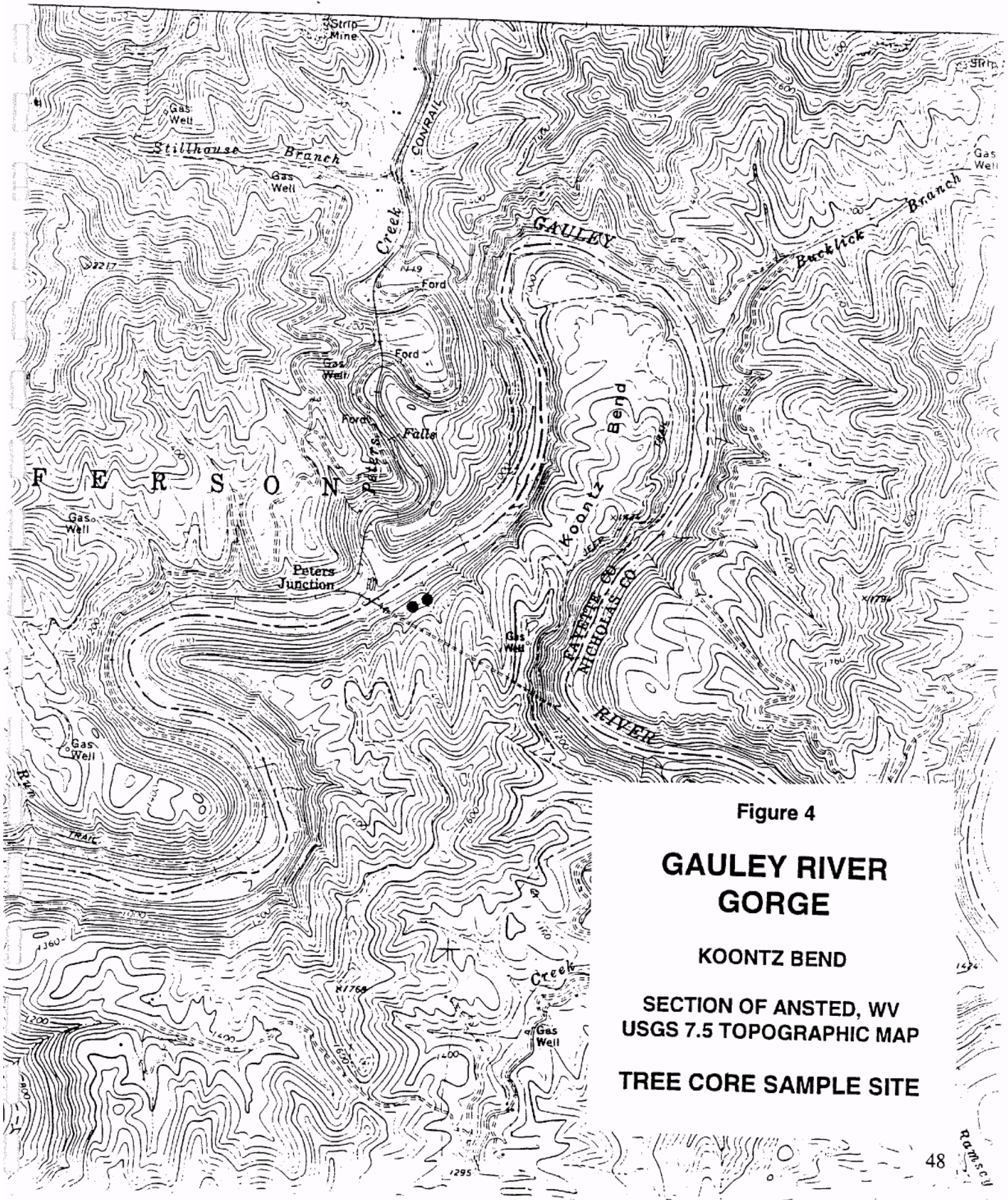


Figure 4

GAULEY RIVER GORGE

KOONTZ BEND

SECTION OF ANSTED, WV
USGS 7.5 TOPOGRAPHIC MAP

TREE CORE SAMPLE SITE

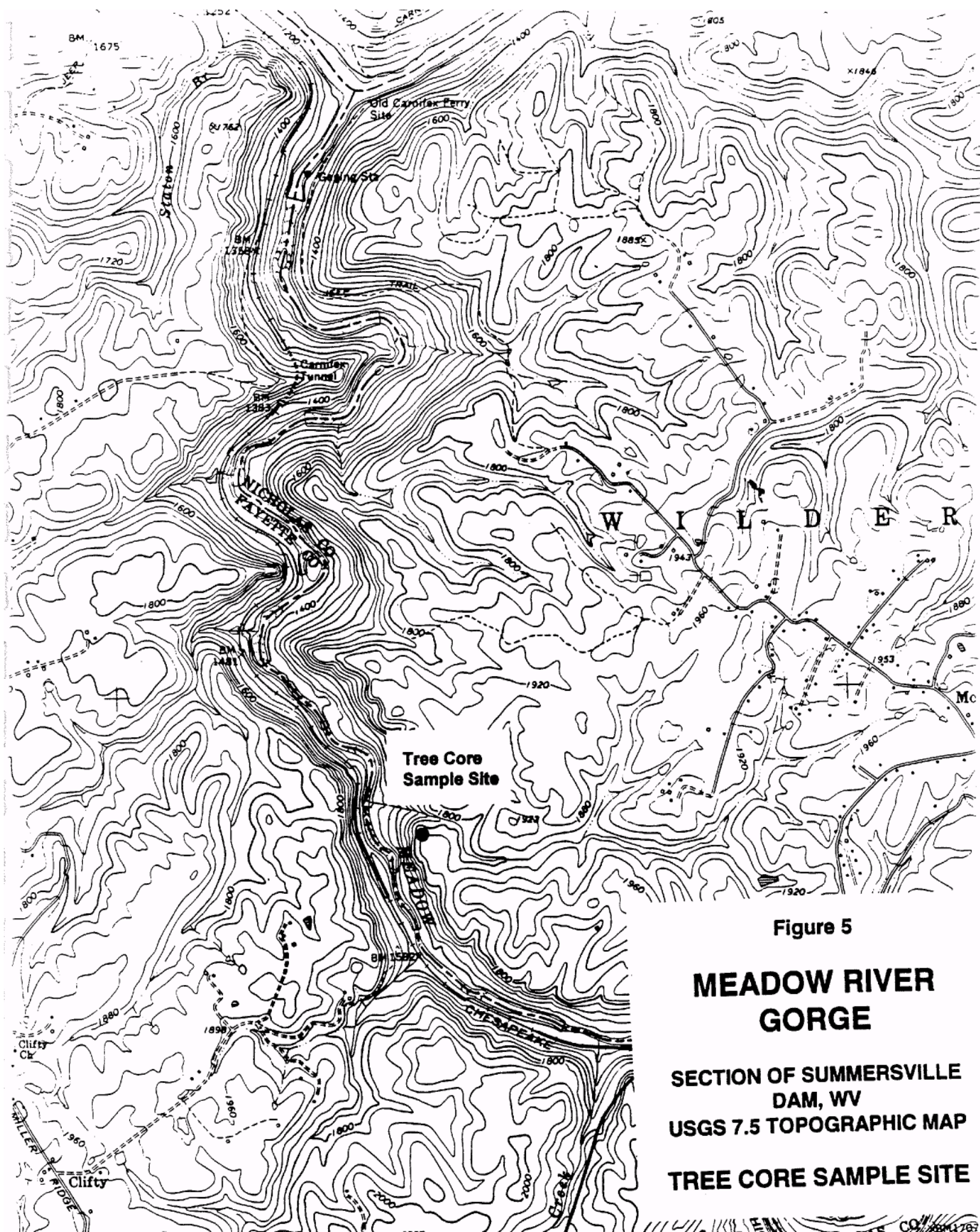


Figure 5

MEADOW RIVER GORGE

SECTION OF SUMMERSVILLE
DAM, WV
USGS 7.5 TOPOGRAPHIC MAP
TREE CORE SAMPLE SITE

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SUPPLEMENTAL REPORT

RECONNAISSANCE VEGETATION STUDY OF THE BLUESTONE, NEW, AND GAULEY RIVER GORGES (GROUND COVER SUPPLEMENT)

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Prepared for:

NATIONAL PARK SERVICE

**Order No. 1443PX478094215
Requisition No. 1732**

MAY 3,1995

TABLE 1a
GORGE VEGETATION RECONNAISSANCE STUDY
BLUESTONE RIVER GORGE (PIPESTEM STATE PARK)
LOWER QUADRAT-GROUND COVER²

HERBACEOUS PLANTS	AVG COVERAGE (%)	REL COVER- AGE (%)	FREQ (%)	REL FREQ (%)
Polystichum acrostichoides	1.5	17.14	10	7.14
Galium sp.	0.5	5.71	20	14.27
Leersia sp.	0.5	5.71	10	7.14
Viola papilionacea	0.75	8.57	30	21.43
Unknown dicot	0.25	2.86	10	7.14
Desmodium sp.	0.25	2.86	10	7.14
Dryopteris marginalis	1.5	17.14	10	7.14
Carex plantaginea	0.25	2.86	10	7.14
Panicum boscii	1.5	17.14	10	7.14
Panicum dichotomum	0.25	2.86	10	7.14
Aster divaricatus	1.5	17.14	10	7.14
Solidago sp.¹	-	-	-	-
Disporum lanuginosum¹	-	-	-	-
Polygonatum biflorum¹	-	-	-	-
Sedum ternatum¹	-	-	-	-
Erythronium americanum¹	-	-	-	-
Thalictrum dioicum¹	-	-	-	-
Galium pilosa¹	-	-	-	-
Dentaria diphylla¹	-	-	-	-
Dryopteris spinulosa¹	-	-	-	-
TOTALS	8.75	100	140	100

¹ Other herbaceous species observed in 0.1 ha. but not in 1m x 1m quadrats.

² Methods for calculating coverage based on Daubenmire, 1968.

TABLE 2a
GORGE VEGETATION RECONNAISSANCE STUDY
BLUESTONE RIVER GORGE (PIPESTEM STATE PARK)
MIDSLOPE QUADRAT-GROUND COVER² 141

HERBACEOUS PLANTS	AVG % COVERA GE	REL COVER- AGE (%)	FREQ (%)	REL FREQ (%)
<i>Dioscorea quaternata</i>	2.50	10.53	50.00	13.51
<i>Solidago caesia</i>	0.50	2.11	20.00	5.41
<i>Allium cernuum</i>	4.25	17.89	30.00	8.11
Unknown species	1.00	4.21	40.00	10.81
<i>Potentilla canadensis</i>	4.50	18.95	30.00	8.11
<i>Geranium maculatum</i>	0.50	2.11	20.00	5.41
<i>Antennaria plataginifolia</i>	4.75	20.00	40.00	10.81
<i>Stellaria pubera</i>	0.50	2.11	20.00	5.41
<i>Sedum ternatum</i>	0.75	3.16	30.00	8.11
<i>Monarda fistulosa</i>	1.50	6.32	20.00	5.41
Unknown sp. (Creeper)	1.50	6.32	10.00	2.70
<i>Stellaria pubera</i>	0.50	2.11	20.00	5.41
<i>Cunila origanoides</i>	0.25	1.05	10.00	2.70
<i>Desmodium</i> sp.	0.25	1.05	10.00	2.70
Unknown sp.	0.25	1.05	10.00	2.70
<i>Aster infirmus</i>	0.25	1.05	10.00	2.70
<i>Taenidia integerrima</i> ¹	-	-	-	-
<i>Houstonia tenuifolia</i> ¹	-	-	-	-
<i>Arabis laevigata</i> ¹	-	-	-	-
<i>Dryopteris marginalis</i> ¹	-	-	-	-
<i>Polystichum acrostic hoides</i> ¹	-	-	-	-
TOTALS	23.75	100.00	370.00	100.00

¹Other herbaceous species observed in 0.1 ha. area but not in 1m x 1m quadrats.

² Methods for calculating coverage based on Daubenmire, 1968.

TABLE 3a
GORGE VEGETATION RECONNAISSANCE STUDY
BLUESTONE RIVER GORGE (PIPESTEM STATE PARK)
UPPER SLOPE QUADRAT-GROUND COVER²

HERBACEOUS PLANTS	AVG. % COVERAGE	REL COVERAGE (%)	FREQ (%)	REL FREQ (%)
Uvularia perfoliata	9.25	45.12	10.00	3.23
Stellaria pubera	1.00	4.88	40.00	12.90
Polygonatum sp.	0.25	1.22	10.00	3.23
Carex laxiflora	0.75	3.66	30.00	9.68
Dioscorea villosa	0.25	1.22	10.00	3.23
Solidago caesia	2.50	12.20	50.00	16.13
Viola sp.	0.50	2.44	20.00	6.45
Unknown species	0.25	1.22	10.00	3.23
Galium pilosa	0.50	2.44	20.00	6.45
Carex prasina	3.25	15.85	30.00	9.68
Potentilla canadensis	0.25	1.22	10.00	3.23
Galinsoga sp.	0.25	1.22	10.00	3.23
Stellaria pubera	0.25	1.22	10.00	3.23
Asclepias sp.	0.25	1.22	10.00	3.23
Brachyelytrum erectum	0.25	1.22	10.00	3.23
Prenanthes alba	0.25	1.22	10.00	3.23
Vicia sp.	0.25	1.22	10.00	3.23
Unknown trif lolate sp.	0.25	1.22	10.00	3.23
TOTALS	20.50	100.00	310.00	100.00
Apios americana ¹		Panicum dichotomum ¹		
Arabis canadensis ¹		P. boscii ¹		
Dioscorea villosa ¹		Scuteilaria sp. ¹		
Collinsonia candensis ¹		Hypericum sp. ¹		
Taenidia integerrima ¹		Houstonia sp. ¹		
Unknown Poaceae ¹				

¹ Other herbaceous species observed 0.1 ha. area but not in 1m x 1m quadrats.

² Methods for calculating coverage based on Daubenmire, 1968.

TABLE 4a
GORGE VEGETATION RECONNAISSANCE STUDY
GAULEY RIVER GORGE (CARNIFEX FERRY STATE PARK)
LOWER SLOPE QUADRAT-GROUND COVER²

HERBACEOUS PLANTS	AVG % COVERAGE	REL COVER- AGE (%)	FREQ (%)	REL FREQ (%)
Dryopteris marginalis	1.50	7.41	20.00	15.38
D. intermedia	16.50	81.48	70.00	53.85
Asarum virginicum	0.25	1.23	10.00	7.69
Polypodium virginianum	0.25	1.23	10.00	7.69
Collinsonia canadensis	1.50	7.41	10.00	7.69
Impatiens sp.	0.25	1.23	10.00	7.69
Polystichum acrostichoides¹	—	—	—	—
TOTAL	20.25	100.00	130.00	100.00

¹ Other herbaceous species observed in 0.1 ha. area but not in 1m x 1m quadrats.

² Methods for computing coverage based on Daubenmire, 1968.

TABLE 5a
GORGE VEGETATION RECONNAISSANCE STUDY
GAULEY RIVER GORGE (CARNIFEX FERRY STATE PARK)
MIDSLOPE QUADRAT-GROUND COVER²

HERBACEOUS PLANTS	COVERAGE (%)	REL COVER (%)	FREQ (%)	REL FREQ (%)
Mitchella repens	0.25	100.00	10.00	100.00
Cypripedium acaule¹	-	--	-	~
TOTAL	0.25	100.00	10.00	100.00

¹ Other herbaceous species observed in 0.1 ha. area but not in 1m x 1m quadrats.

² Methods for calculating coverage based on Daubenmire, 1968.

TABLE 6a
GORGE VEGETATION RECONNAISSANCE STUDY
GAULEY RIVER GORGE (CARNIFEX FERRY STATE PARK)
UPPER SLOPE QUADRAT-GROUND COVER²

HERBACEOUS PLANTS	AVG % COVERAGE	REL % COVERAGE	FREQ (%)	REL FREQ (%)
Mitchella repens	0.25	11.11	10.00	25.00
Viola rotundifolia	2.00	88.89	30.00	75.00
Monotropa uniflora¹	—	—	—	—
Polystichum acrostichoides¹	—	—	—	—
Conopholis americana¹	—	—	—	—
Carex sp.¹	—	—	—	—
Thelypteris noveboracensis¹	—	—	—	—
Solidago caesia¹	—	—	—	—
TOTAL	2.25	100.00	40.00	100.00

¹Other herbaceous species observed in 0.1 ha. area but not in 1m x1m quadrats. ²

TABLE 7a
GORGE VEGETATION RECONNAISSANCE STUDY
NEW RIVER GORGE
LOWER QUADRAT-GROUND COVER²

HERBACEOUS PLANTS	AVG % COVERAGE	REL (%) COVERAGE	FREQ (%)	REL FREQ (%)
<i>Polymnia uvedalia</i>	12.75	43.97	70.00	36.84
<i>Geranium maculatum</i>	1.75	6.03	20.00	10.53
<i>Apios americana</i>	0.25	0.86	10.00	5.26
<i>Arisemea triloba</i>	0.25	0.86	10.00	5.26
<i>Panicum boscii</i>	0.25	0.86	10.00	5.26
<i>Circaea quadrisulcata</i>	0.25	0.86	10.00	5.26
Unknown Poaceae	11.50	39.66	30.00	15.79
<i>Uvularia perfoliata</i>	0.25	0.86	10.00	5.26
<i>Galium tinctorium</i>	1.50	5.17	10.00	5.26
<i>Smilacina racemosa</i>	0.25	0.86	10.00	5.26
<i>Polygonatum</i> sp.¹	—	—	—	—
<i>Disporum lanuginosum</i>¹	—	—	—	—
<i>Cirsium vulgare</i>¹	—	—	—	—
<i>Geum canadense</i>¹	—	—	—	—
TOTALS	29.00	100.00	190.00	100.00

¹ Other herbaceous species observed in 0.1 ha. area but not in 1m x 1m quadrats.

² Methods for calculating coverage based on Daubenmire, 1968.

TABLE 8a
GORGE VEGETATION RECONNAISSANCE STUDY
NEW RIVER GORGE
MIDSLOPE QUADRAT-GROUND COVER²

HERBACEOUS PLANTS	AVG % COVERAGE	REL (%) COVERAGE	FREQ (%)	REL FREQ (%)
Eupatorium sp.	3.75	18.07	10.00	4.17
Apios americana	1.50	7.23	10.00	4.17
Chelone glabra	4.50	21.69	30.00	12.50
Eupatorium fistulosum	1.50	7.23	10.00	4.17
Helianthus sp.	0.25	1.20	10.00	4.17
Disporum lanuginosum	0.25	1.20	10.00	4.17
Dioscorea villosa	4.75	22.89	40.00	16.67
Carex sp.	0.25	1.20	10.00	4.17
Solidgo caesia	1.75	8.43	20.00	8.33
Panicum boscii	0.25	1.20	10.00	4.17
Eupatorium sp.	0.50	2.41	20.00	8.33
Carex sp.	0.25	1.20	10.00	4.17
Aster divaricatis	0.25	1.20	10.00	4.17
Brachyelytrum erectum	0.25	1.20	10.00	4.17
Aster sp.	0.25	1.20	10.00	4.17
Sanicula sp.	0.25	1.20	10.00	4.17
Eupatorium sp.	0.25	1.20	10.00	4.17
Asplium platyneuron ¹	—	—	—	—
Smilacina racemosa ¹	—	—	—	—
Polystrichum acrostichoides ¹	—	—	—	—
Botrychium virginianum ¹	—	—	—	—
Viola sp. ¹	—	—	—	—
Galium sp. ¹	—	—	—	—
TOTALS	20.75	100.00	240.00	100.00

¹ Other herbaceous species observed in 0.1 ha. area but not in 1m x 1m quadrats.

² Methods for calculating coverage based on Daubenmire, 1968.

TABLE 9a
GORGE VEGETATION RECONNAISSANCE STUDY
NEW RIVER GORGE (PIPESTEM STATE PARK)
UPPER QUADRAT-GROUND COVER²

HERBACEOUS PLANTS	AVG % COVERAGE	REL (%) COVERAGE	FREQ (%)	REL FREQ (%)
Cunila origanoides	0.50	10.00	10.00	11.11
Viola sp.	0.50	10.00	20.00	22.22
Smilacina racemosa	1.50	30.00	10.00	11.11
Chimaphila maculata	0.25	5.00	10.00	11.11
Smilax herbacea	0.50	10.00	20.00	22.22
Smilax glauca	0.25	5.00	10.00	11.11
Gaultheria procumbens	1.50	30.00	10.00	11.11
Aster divaricatus¹	—	—	—	—
Thelypteris noveboracensis¹	—	—	—	—
Solidago caesia¹	—	—	—	—
Medeola virginiana¹	—	—	—	—
Stellaria pubera¹	—	—	—	—
Goodyera pubescens¹	—	—	—	—
TOTALS	5.00	100.00	90.00	100.00

¹Other herbaceous species observed in 0.1 ha. area but not in 1 m x 1 m quadrats

² Methods for calculating coverage based on Daubenmire, 1968.

TABLE 10a
GORGE VEGETATION RECONNAISSANCE STUDY
SUMMARY OF AVERAGE PERCENT GROUND COVER¹
GAULEY RIVER GORGE (CARNIFEX STATE PARK)

BRYOPHYTES/ROCKS/ HERBACEOUS PLANTS/ WOODY DEBRIS	AVG % COVERAGE		
	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
Bryophytes	2.00	4.25	7.75
Rocks	0.00	0.00	4.00
Woody Debris	11.00	18.25	11.75
Herbs	2.25	0.25	20.25

¹ Methods for calculating coverage based on Daubenmire, 1968.

TABLE 11a
GORGE VEGETATION RECONNAISSANCE STUDY
SUMMARY OF AVERAGE PERCENT GROUND COVER¹
BLUESTONE RIVER GORGE (PIPESTEM STATE PARK)

BRYOPHYTES/ROCK S/ HERBACEOUS PLANTS/ WOODY DEBRIS	AVG % COVERAGE		
	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
Bryophytes	5.00	6.20	7.75
Rocks	2.50	17.50	4.00
Woody Debris	13.50	11.00	11.75
Herbs	20.50	23.75	8.75

¹ Methods for calculating coverage based on Daubenmire, 1968.

TABLE 12a
GORGE VEGETATION RECONNAISSANCE STUDY
SUMMARY OF AVERAGE PERCENT GROUND COVER ¹
NEW RIVER GORGE

BRYOPHYTES/ROCK S/ HERBACEOUS PLANTS/ WOODY DEBRIS	AVG % GROUND COVER		
	UPPER SLOPE	MIDSLOPE	LOWER SLOPE
Bryophytes	7.50	3.20	2.75
Rocks	1.50	16.75	23.25
Woody Debris	21.00	7.50	13.25
Herbs	5.00	20.75	29.00

¹ Methods for calculating coverage based on Daubenmire, 1968.