LITERATURE REVIEW

OF

GEOLOGY/SOILS, PLANTS AND ANIMAL INFORMATION

PERTINENT TO

NEW RIVER GORGE NATIONAL RIVER, WEST VIRGINIA

Conducted from September 1980 through December 1980

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Submitted to the New River Gorge National River Staff

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INTRODUCTION

The purpose of this literature review was to summarize the published information of pertinence and specific to the New River Gorge from Hinton, West Virginia to Gauley Bridge, West Virginia. The three subject areas of geology, plants and animals were researched within the time limitations and constraints of this project.

The primary emphasis was on literature in public, college and university libraries in West Virginia. Limited contacts for literature relating to the New River Gorge were made in Virginia, Maryland, Ohio and the District of Columbia. Additional checks were made with some state and federal natural resource management agencies operating in West Virginia.

It is recognized that a satisfactory comprehensive literature review will require additional searching in libraries and updating of existing research studies.

The organization of this paper is to consecutively cover the topics of geology, plants (botany), and animals (fauna).

HISTORICAL GEOLOGY

Mississippian Period

The oldest rocks exposed anywhere in the New River Gorge are from the Mississippian Period, which began about 345 million years ago. The beginning of this period is marked by the close of the Acadian Orogeny. This orogenic disturbance caused a major uplift of the land masses to the east of West Virginia-(WV). Sediments washed in from this area settled in WV forming the Devonian Strata which underly most all of WV.

During the early Mississippian, this area was sufficiently affected by the Acadian uplift to cause a mixed, but predominantly nonmarine environment. The highlands east of WV were more or less steadily rising, thus furnishing a source of sediments for the basinal areas to the west. During the middle Mississippian the weight from the preceeding deposits caused a general subsidence of the area, and a marine environment predominated. Subsequently, more deposits were laid down, and the seas again retreated from WV. The late Mississippian begins with this occurrence and marks the last time that the whole area was covered with a marine environment.

The sediments laid down during the Late Mississippian comprise the Mauch Chunk Group; they are nonmarine and are the oldest rock strata found along New River. They are divided into four formations, the Bluefield, Hinton, Princeton, and Bluestone. The sediments of the Late Mississippian are for the most part clastic, with sandstone and shale predominating. Scattered thin coal seams occur, but they are not of economic importance. The Bluestone formation at the top of the Mississippian is characterized by an abundance of bright-red shale that contrasts sharply with the sandstone, gray shale and coal of the overlying Pennsylvanian.

As the Mississippian Period ended, West Virginia emerged and became for the most part a land surface, thus subjecting the area to erosion. Thus, most everywhere the Pennsylvanian lies unconformably upon those of the Mississippian.

The predominant life forms of the Mississippian were the

invertebrates. Among the invertebrates, crinoids and blastoids reached their climax during this period. Lacy bryozoa and spiny brachiopods expanded. Foraminifera became important for the first time. Gastropods and pelecypods were also important, and trilobites were approaching extinction.

Among the vertebrates, fish were less important than in the Devonian but were still abundant. Among the Mississippian fish were sharks who fed on crustaceans and were equipped with teeth that could crush the shells of their prey. The principle land animals were amphibians whose footprints have been found in the terrestrial deposits, but remains of these are scarce.

No important evidences of abundant forests have been found. However, the land plants are believed to have increased in abundance as time progressed from the Devonian through the Mississippian and into the Pennsylvanian when they played such an important part in the geologic history of the earth and the area of New River.

The Mississippian period lasted approximately 30 million years (Figure 1).

Pennsylvanian Period

The Pennsylvanian Period began about 315 million years ago and lasted approximatley 45 million years (Figure 1). The Pennsylvanian is particularly important because it was during this period of extensive and luxuriant swamp forests that our important coal deposits originated.

At the beginning of the Pennsylvanian Period, a mountainous belt extending from Newfoundland to Alabama roughly occupied the area some distance to the east of what is now the State of WV. This highland formed the principal source of material for the vast deposits of the State. The seas of the continental interior withdrew at the close of the Mississippian time, thus leaving the soft sediments exposed to rapid erosion. Erosion cut many channels, some as much as 300 feet deep, and then the first Pennsylvanian strata were laid down, burying the old erosion surface at the top of the Mississippian.

A broad basin that included essentially all of WV and much of the continental interior began forming in early Pennsylvanian

time and continued throughout the period and into the Permian Period that followed. Subsidence was slow, and sediment from the highlands was transported to the basin and deposited in large deltas. The rate of deposition was essentially the same as the subsidence so that only very occasionally did any of the area of WV drop below sea level. It was essentially a low, swampy area, close to but not below sea level, where lush green swamp forests abounded at intervals over the surface of the deltas. As time went on, the remains of these forests accumulated in stagnant water to form vast deposits of peat that were subsequently gradually altered by heat and pressure through the ages to form extensive coal deposits we know today.

Peat deposition was periodically interrupted by vast quantities of sand, gravel, silt, clay, and some calcareous material. Thus were formed the immense thicknesses of sandstone, conglomerate, siltstone, and shale that, along with the coal seams and a few limestone layers, make up the Pennsylvanian section. Many of the sandstones, particularly the Salt sands of the Pottsville, have formed important shallow reservoirs for oil and gas production.

The various deposits occurred for the most part in cycles, the marine limestone formed at times when the delta surface was below sea level, the peat during long periods of swamp conditions when little sediment was coming in from the source to the east, and the clastic materials were washed in at times of vigorous clastic supply to the deltas.

The Pennsylvanian of WV has been divided into four main parts that are from the bottom upward, the Pottsville Group, the Allegheny Formation, the Conemaugh Group, and the Monongahela Group. The Pottsville Group in turn consists of three formations, which are in ascending order the Pocahontas, New River, and Kanawha. The youngest rocks in New River are from the latest formation of the Pottsville.

In describing the deposition of Pennsylvanian beds in WV, the state should be divided into a Southern and Northern basin, (the area of New River in the southern). During the time of Pottsville deposition, the northern basin was more of a platform receiving much less deposition than the deeper southern

basin. See Figure 2.

The Pocahontas Formation, the lowest unit of the Pottsville Group, is known only in southeastern WV where it reaches a reported maximum thickness of about 720 feet. It contains several important coal seams, including the famous Pocahontas coals.

The New River Formation extends somewhat further northwest, into the northern basin but is important only in the southern basin where it reaches a probable maximum thickness of 1,000 feet. A thickness of about 100 feet has been reported for Mineral and Grant Counties of the eastern panhandle. The New River contains, among others, the Iaeger, Sewell, Welch, Raleigh, Beckley, and Fire Creek coal seams. This formation has the most exposure in the area of New River, and the coal seams have in the past had a profound effect on the development of the New River Gorge area.

The Kanawha Formation is extensively exposed in a belt extending northeastward from the Kentucky line to the Deer Park anticline in Randolph and Uphshur Counties. The outcrop belt is about 50 miles wide at the Kentucky boundary and narrows to about 12 miles in Upshur County. It reaches a maximum thickness of about 2,100 feet in McDowell County.

Most characteristic of the life of the Pennsylvanian are the fast growing, soft tissued trees and other plants that formed the vast swamp forests of this period. Perhaps nowhere else on the continent were these more important than in WV, for it is from these that almost all of the commercial coal deposits of the state were formed. Although seed-bearing plants were present the spore bearing plants were more abundant. Ferns, horsetails, rushes and the like, which we know only as relatively small plants, commonly grew to large tree size. Conifers were still very primitive, and flowering plants had not yet come into existence.

Primitive insects, including many of the largest known, were abundant. Also important were the centipedes, spiders, scorpions, and small land snails. Fishes continued to be important.

Invertebrate marine life continued in abundance. Most important were the brachiopods, lacy bryozoa, pelecypods, and

gastrapods. Foraminifera, mostly of very small size, were also abundant and are important in correlation of Pennsylvanian rocks outside of WV. Corals and echinoderms were also present. Blastoids died out in the Pennsylvanian.

The last deposits to be laid down in what is now the area of WV were during the Permian, which directly follows the Pennsylvanian. However, these rocks have long since eroded away, leaving only Pennsylvanian and some Mississippian age rocks exposed in the area of those counties containing portions of the New River Gorge National Park. A general stratigraphic column showing the relative locations of each formation of the Pennsylvanian and Mississippian Periods is shown in Figure 3. A more detailed discussion of the specific rock strata along New River will follow in a section on Stratigraphy.

New River-Most Recent Geologic History

The close of the Permian which also closed the Paleozoic Era (Figure 3), was marked by the Appalachian Orogeny. Tremendous earth pressures buckled and elevated the thousands of feet of sedimentary rocks laid down during the Paleozoic Era into the original Appalachian Mountains. Rivers were formed in these mountains and flowed down out of them. For more than a hundred million years they flowed across these mountains until the mountains were nearly completely worn away. This duration of time is recognized as the Mesozoic Era. After this vast plain had been produced, more earth pressures again elevated the whole region into a great plateau. There was no buckling, just simply the whole region was uplifted with the many rivers that had worn it down still flowing across it's surface. However, this plain was lifted higher toward the east, with the general surface dipping to the west. As the land was being re-elevated, the rivers which were carried upward had renewed cutting power and began sawing their way downward through the rising rocks. This caused the rivers to cut deep canyons and valleys down into the plateau which has continued to the present day.

The New River remains as a remnant of one of those mighty Rivers which helped to level the original Appalachian Mountains. This ancient river(Teays River), was a thousand miles long

and had its source near the top of the Blue Ridge in North Carolina. From there it followed a northwestwardly course across Virginia and into WV as far as Charleston and Nitro, along the same route followed by the New and Kanawha Rivers today. From Nitro it continued due west to Huntington and on past Ashland, Kentucky, towards Portsmouth, Ohio, where it swerved northward to Chillicothe, Ohio. There it swung westwardly again crossing Indiana and continuing across central Illinois as far as the present Illinois valley. Then it turned southward past St. Louis and entered a northern arm of the Gulf of Mexico, which extended up what is now the lower Mississippi Valley.

This ancient river which helped to wear down the original Appalachian mountains developed a meandering course as it flowed westwardly across the great plain which it helped to create. When the Appalachian plateau and its rivers were uplifted, the rivers maintained their meandering direction. This twisting and turning of the rivers course is an indication that it once flowed across a great plain.

The Teays River went out of existence during the Great Ice Age, and was replaced by the Ohio River as a result of the glaciation. When the glacier spread southward from Canada it moved entirely across the lower half of the river between Chillicothe, Ohio and its mouth below St. Louis. Meanwhile, the upper half of the Teays was blocked by the ice front, which stood like a towering dam across its valley at Chillicothe. This immense wall of ice caused the water of the river to become impounded like a lake some two hundred miles long, extending from Chillicothe across the remainder of Ohio and two-thirds of the distance across WV to about as far as Hawks Nest State Park. The water level rose until it found an overflow point at the lowest point on the lake rim, which happened to be near Portsmouth, Ohio. Here, the overflowing lake followed a westerly route toward Cincinnati and along the southern borders of Indiana and Illinois to the Gulf of Mexico. This new course then became established as the lower part of the Ohio River.

The Teays Lake remained in existence for about 25,000 years. After the Teays Lake became drained, the Teays River did not return to that portion of its valley between Nitro and Huntington. Instead, it is believed to have been diverted by piracy of a small stream which entered the Ohio River at Point Pleasant, West Virginia. By headward erosion this stream extended its course toward Nitro, cut a water gap through the high ridge there, and diverted the river through it toward Point Pleasant, thereby forming the lower course of the Kanawha River. In this way the upper portion of the Teays River (New-Kanawha), became a tributary of the new Ohio River.

The long history of the Teays River is somewhat more complicated than the above description, but the major events affecting its history have been covered. The changes which occurred during the Ice Age, converting a section of it into a lake, and its final elimination as a great river, took place over a long period of time - perhaps several hundreds of thousands of years. While the lower half of the river was being overriden and buried by the ice, and its mid section converted into a lake, the headward portion continued to flow down to the lake without interruption. This headward portion, from North Carolina to Nitro, still flows today an the New and Kanawha Rivers.

Numerous popular articles have referred to New River as "the oldest river in the world", "oldest river in North America", etc. These claims seem to be circumstantial and unproven. Fridley (1950) stated that New River "is one of the oldest streams draining the Appalachian Highlands.

This summary utilized the following as primary sources:

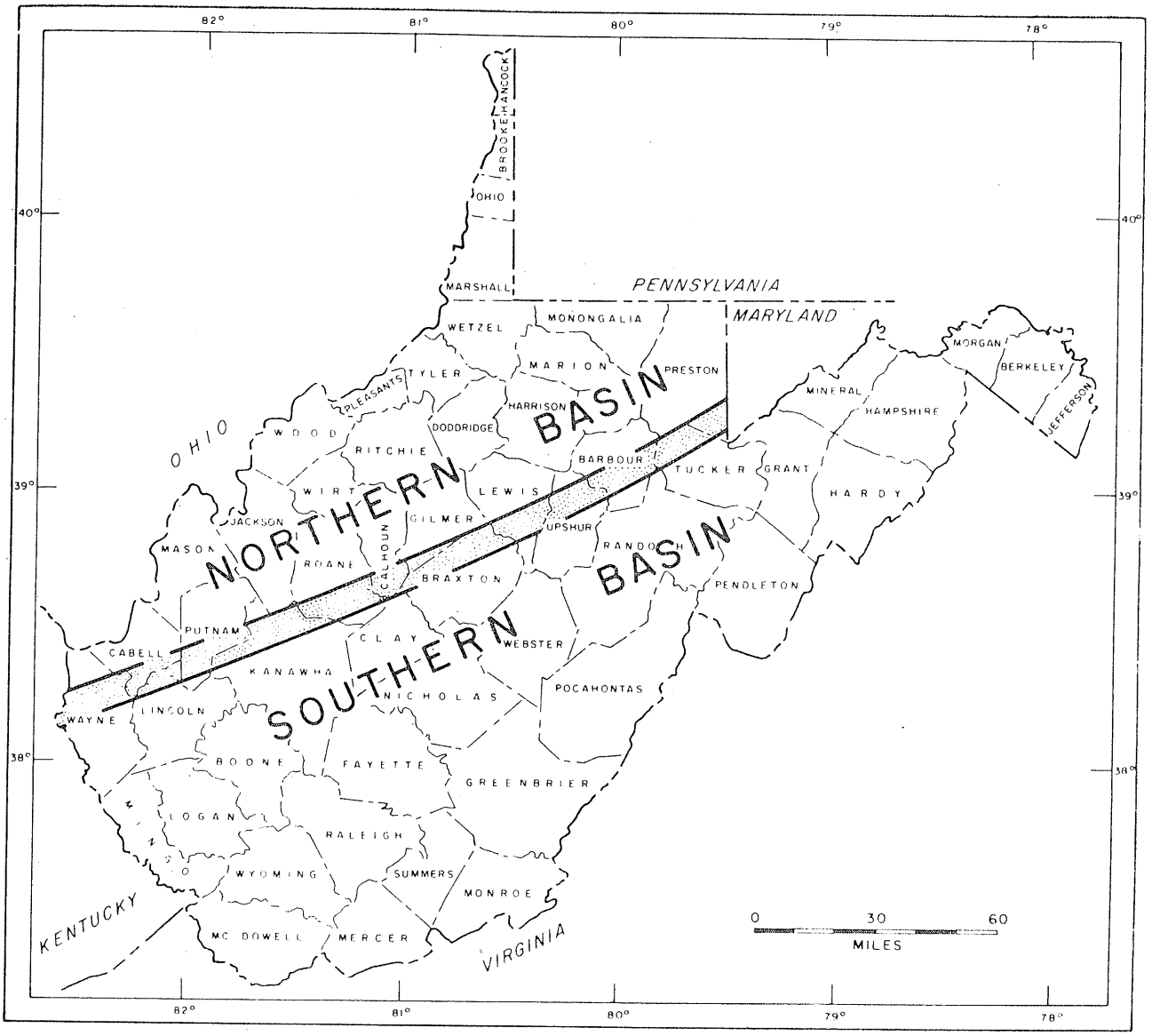
1. Cardwell, Dudley H. 1975. Geologic History of West Virginia.
2. Fridley, Harry. 1950. The Geomorphic History of New-Kanawha.
3. Janssen, Raymond E. 1973. Earth Science - A Handbook on the Geology of West Virginia.

Table of Ages (modified from several recent sources)

Period	Duration*	Began**	Ended**
Quaternary	2.5	2.5	
Tertiary	63.5	66	2.5
Cretaceous	69	135	66
Jurassic	50	185	135
Triassic	40	225	185
Permian	45	270	225
Pennsylvanian	45	315	270
Mississippian	30	345	315
Devonian	60	405	345
Silurain	25	430	405
Ordovician	70	500	430
Cambrian	100	600	500
Ante-Cambrian	400	1,000	600
First evidences of life known		3,200	

* Millions of years. ** Millions of years ago.

Figure I



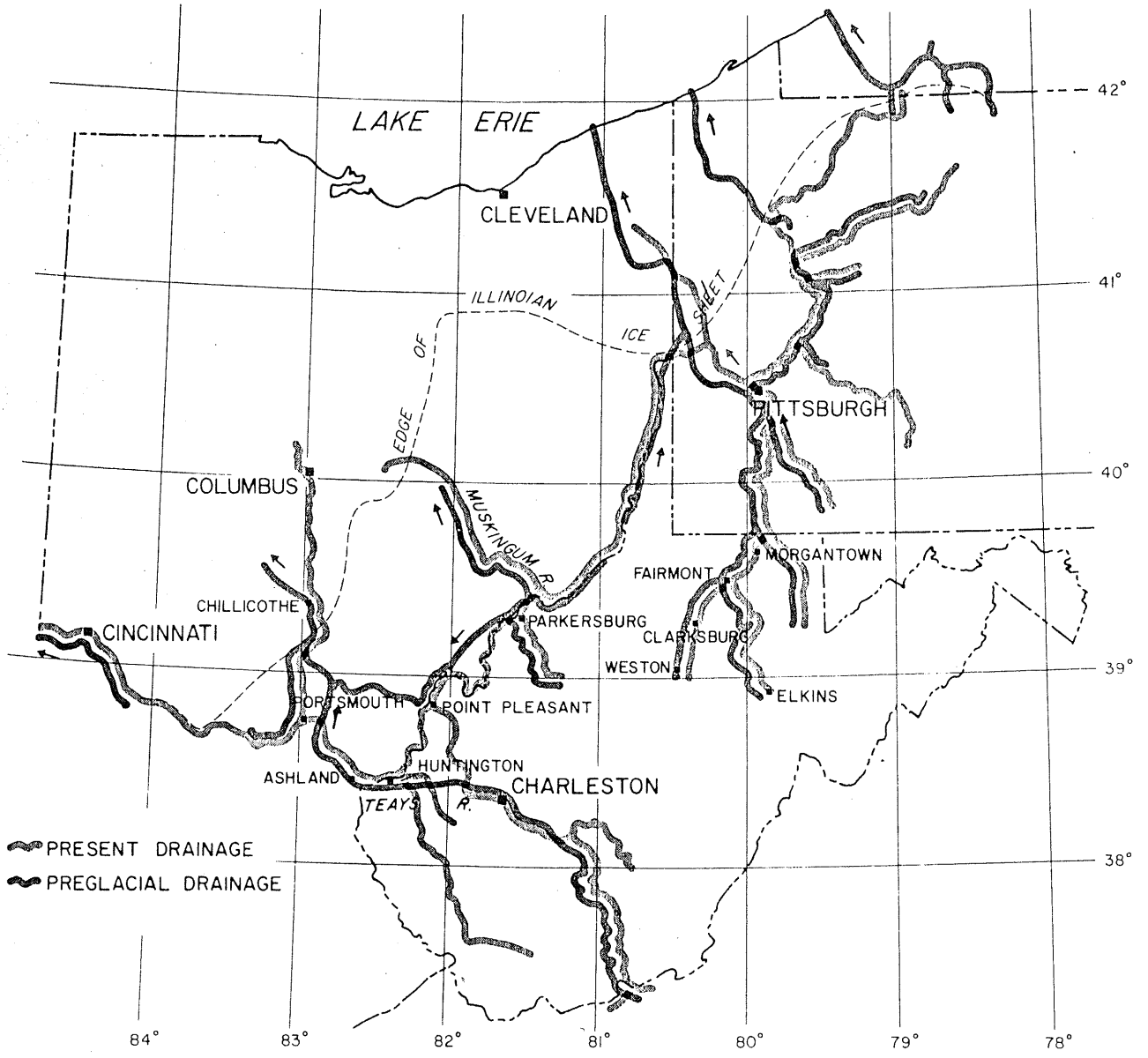
Map of West Virginia Showing Coal Basins. (Modified from Barlow, 1971, p. 3.)

Figure II

GEOLOGIC ERAS, PERIODS AND EPOCHS			ROCK TERMINOLOGY	HISTORY	
CENOZOIC ERA				Lake deposits and drainage changes due to glaciation to north	
MESOZOIC ERA	CRETACEOUS JURASSIC TRIASSIC			Igneous activity in Pendleton and surrounding counties	
PALEOZOIC ERA	PENNSYLVANIAN	PERMIAN	DUNKARD GROUP	Appalachian Orogeny. West Virginia was uplifted and became an erosion surface. For more than 200 million years it has never been invaded by the sea and no extensive sediments have been deposited.	
		LATE	MONONGAHELA GROUP CONEMAUGH GROUP		
		MIDDLE	ALLEGHENY FORMATION		
		EARLY	POTTSVILLE GROUP: KANAWHA FM. / NEW RIVER FM. / POCAHONTAS FM.	Swamp conditions throughout most of the State resulted in the preservation of plant remains which were altered to peat and in turn altered to the many coal seams.	
	MISSISSIPPIAN	LATE	MAUCH CHUNK GROUP	Nonmarine environment. Shale and sandstone predominate, red beds very predominant near top.	
		MIDDLE	GREENBRIER GROUP	Shallow sea once again covered most of West Virginia. Carbonate deposition predominates. Last important marine deposition in West Virginia.	
		EARLY	MACCRADY FORMATION POCONO GROUP	Uplift continued and a nonmarine environment existed. Sandy shales predominate.	
	DEVONIAN	LATE	HAMPSHIRE FORMATION CHEMUNG GROUP BRALLIER FORMATION	Shoreline gradually shifted westward, causing abundant continental beds which were deposited farther and farther westward throughout the epoch.	Acadian Orogeny with main uplift to northeast
		MIDDLE	HARRELL SHALE MAHANTANGO FORMATION MARCELLUS FORMATION	Uplift to east provides clastic sediments for marine dark shale with sandstone layers.	
			ONESQUE. THAW. STAGE: TIOGA BENTONITE	Volcanic activity to east results in thin bentonite zone.	
			ONONDAGA LIMESTONE / HUNTERS VILLE CHERT / NEEDMORE SHALE	Slight subsidence. Shale deposition predominant in northeast, chert in southeast, passing to cherty limestone in west.	
		EARLY	ORISKANY SANDSTONE	Sea somewhat shallower. Blanket sandstone deposition.	
			HELDERBERG GROUP	Slight submergence creates a predominantly carbonate-producing environment, but with invasions of sand and clay.	
	SILURIAN	CAYUGAN LATE	TONOLOWAY FORMATION (BLOOMSBURG FACIES)	Sea covered most of the State. Carbonates predominate in southwest. Evaporite deposition in restricted sea of northern West Virginia.	
			WILLS CREEK FORMATION (BLOOMSBURG FACIES)	Red delta deposits in northeastern West Virginia; marine shale and limestone to southwest.	
			WILLIAMSPORT FORMATION (BLOOMSBURG FACIES)	Red bed deposition continues in northeast; shallow sea sandstone deposition in rest of State.	
		NIAGARAN MIDDLE	MCKENZIE FORMATION	Tidal flat in northeast marks beginning of red bed deposition. Shallow marine carbonates in southwest.	
			ROCHESTER SHALE KEEFER SANDSTONE ROSE HILL FORMATION	Predominantly a shallow marine environment with clastic deposition.	
		EARLY	TUSCARORA SANDSTONE	Shallow sea covered the State. Sandstone deposition.	
	ORDOVICIAN	LATE	JUNIATA FORMATION	Delta-type environment throughout State.	Taconic Orogeny formed an area of high mountains to the east, the source of most of the sediments of the Late Ordovician and Silurian.
			OSWEGO FORMATION	Delta-type environment in eastern West Virginia.	
			REEDSVILLE SHALE	Clastic deposition in marine environment.	
		MIDDLE	TRENTON GROUP: MARTINSBURG FM. / NEALMONT LS.	Carbonate deposition continues to predominate.	Volcanic activity caused deposition of bentonite beds.
			BLACK RIVER GROUP		
			ST. PAUL GROUP		
		EARLY	KNOX: BEEKMANTOWN GROUP	Knox unconformity; predominant in Ohio and western West Virginia.	
	CAMBRIAN	UPPER	KNOX: CONOCOCHEAGUE FM. (EAST) / COPPER RIDGE DOL. (WEST)	Carbonate deposition.	
		MIDDLE	ELBROOK FORMATION		
		LOWER	WAYNESBORO FORMATION	Clastic deposition.	
			TOMSTOWN DOLOMITE	Shallow sea carbonate deposition.	
	Ante-Camb		CHILHOWEE GROUP: ANTIETAM FM.	First fossils in West Virginia rocks.	
			CHILHOWEE GROUP: HARPERS FM. / WEVERTON-LOUDOUN FORMATION	Clastic deposition in narrow trough in eastern West Virginia; beginning of Appalachian Geosyncline.	
			CATOCTIN FORMATION	Volcanic activity in eastern West Virginia.	
PRECAMBRIAN			CRYSTALLINE ROCKS	History complex and obscured.	

Generalized Stratigraphic Column

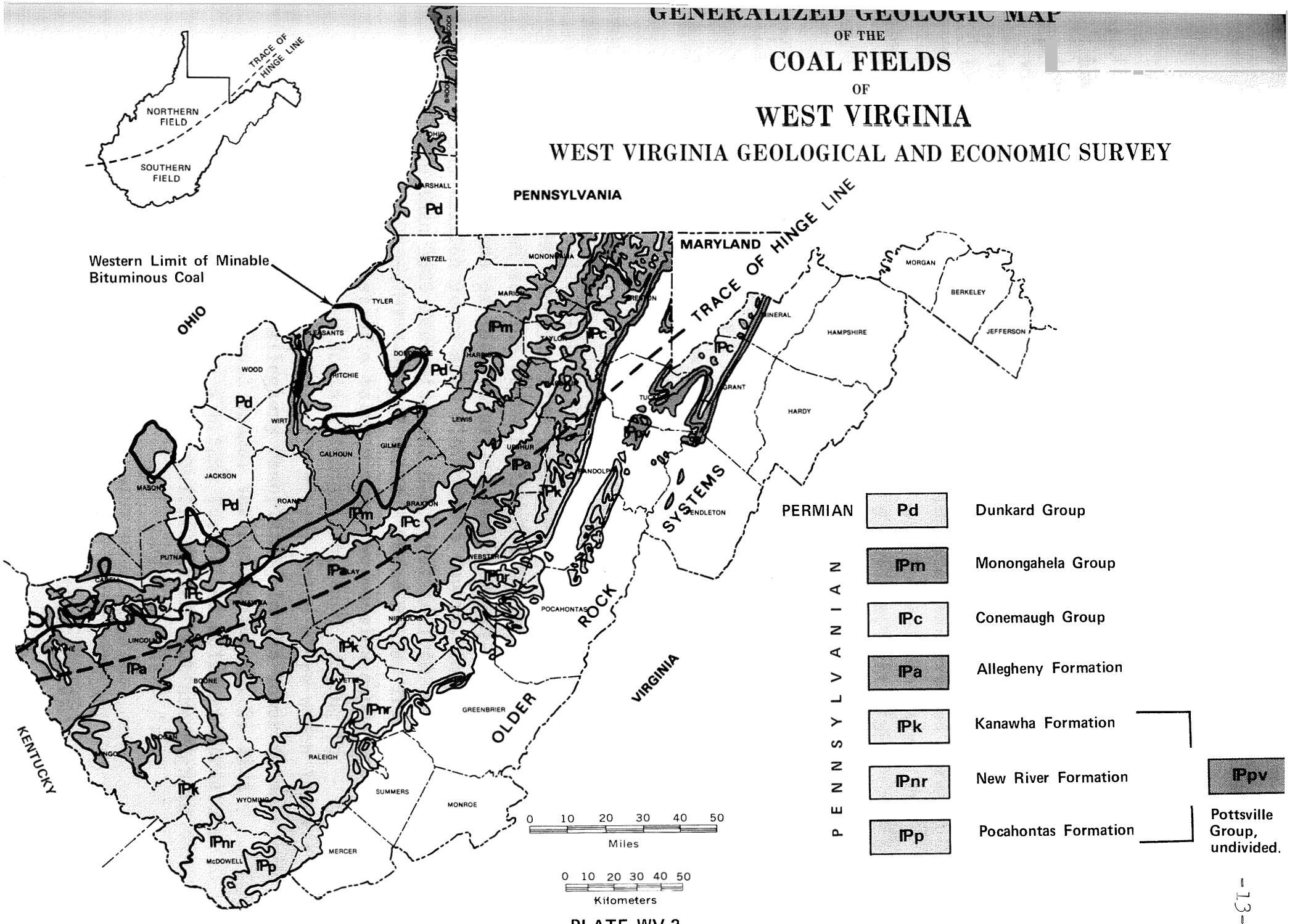
Figure III



Pre-Glacial Drainage Contrasted with Present Drainage in Parts of West Virginia, Ohio, and Pennsylvania. (From various sources.)

Figure IV

GENERALIZED GEOLOGIC MAP
OF THE
COAL FIELDS
OF
WEST VIRGINIA
WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY



PERMIAN

PENNSYLVANIAN

Pd	Dunkard Group
IPm	Monongahela Group
IPc	Conemaugh Group
IPa	Allegheny Formation
IPk	Kanawha Formation
IPnr	New River Formation
IPp	Pocahontas Formation

IPpv — Pottsville Group, undivided.

PLATE WV-2

ECONOMIC GEOLOGY AND STRATIGRAPHY

New River arises in the Blue Ridge Mountains of North Carolina and enters West Virginia at the southeastern corner of Summers County. It then winds northwestward for 89 miles to its junction with the Gauley to form the Kanawha River. In West Virginia it forms the boundaries of, or flows through Monroe, Mercer, Summers, Raleigh and Fayette Counties.

For the first 38 miles in West Virginia, the exposed strata are red, green and medium-gray shales of Mississippian Age. The Mississippian section consists of the Bluestone, Hinton and Bluefield Formations of the Mauch Chunk Series. The Mauch Chunk Series of the Paleozoic Era was formed between 325 and 335 million years ago. The Mauch Chunk ranges from 2200 to 3450 feet in thickness. They contain approximately 31 % sandstone, 62 % shale, 7 % limestone and less than 1 % coal. In this area of the Gorge, the valley is wider and its walls are less steep than those found a few miles down river in Fayette County where the more resistant Pennsylvanian sandstones are present. These Mauch Chunk shales are in evidence as far down river as the mouth of Manns Creek.

Above the Mississippian age shales lie the sandstones and coal seams of the Pennsylvanian (prominent in Fayette County). The Pennsylvanian section contains the Pocahontas, New River and Kanawha Formations of the Pottsville Series which was formed 300 to 325 million years ago. In Fayette County, the Gorge is often less than 3500 feet wide and the river is from 1400 to 1500 feet below the tops of V-shaped walls. These walls, from the river upward, consist of a talus slope, two massive sandstone ledges (Lower and Upper Nuttall Sandstones, each ranging in thickness from 40-110 feet), and a second talus slope which leads to the remnants of the Allegheny Peneplain. In the lower talus slope are three minable coal seams, the Pocahontas No. 3, Fire Creek and Sewell. All have a bright lustre and columnar structure. All are low in ash, sulphur and volatile matter, but are high in fixed carbon.

Geologically, the Fayette County section of New River dates to the Carboniferous Age, and is one of the oldest through which any river flows. The river gradient through most of Fayette County averages 17 feet per mile. The meandering of New River was established during the Permian Age. Successive uplifting near the end of the Permian and during the Cretaceous resulted in increased erosion and the continual deepening of the Gorge. This erosion formed the Schooley Peneplain which was in turn uplifted during the Tertiary Period causing an ever deepening of the Gorge which exposed the coal seams.

The existence of coal in this area was generally unknown until shortly before the C & O Railroad was constructd along the New River Gorge in the 1870's. William B. Rogers of the old Virginia Survey, in his annual report of 1840, stated that Formation XII or the Pottsville Formation contained important coal beds over a wide area along New River. He also assigned the Sewell Coal, which was then being mined on Sewell Mountain to a place in his No. XII series.

Later in 1868 Howell Fisher analyzed the potential for water power development at Sandstone Falls. Fisher also studied the feasibility of iron manufacture based on the local existence of high quality coal, iron and limestone. Thomas S. Ridgeway reported on all the minerals along the C & O Railroad with particular emphasis on coal. In 1870 the Quinnimont Charter Oak and Iron Company was organized to build and operate an iron furnace. The furnace was completed and operated for three years.

Similarly, the Longdale Iron Company opened a coal mine and built coke ovens at Sewell in 1873. The 196 "bee hive" coke ovens provided coke for the company's iron furnaces at Longdale, Virginia.

The construction of the C & O Railroad initiated the economic coal mining boom on New River. The Greenbrier Independent newspaper carried the following article which described the completion of the railroad. "On January 29, 1873, the last spike was driven on the New River bridge at Hawk's Nest, and the special Richmond train of President Wickham proceeded westward to Charleston and to Huntington. At Charleston the event was celebrated by appropriate display of speeches, terminating in a great display of fireworks. At Huntington the union of opposing waters by bands of steel was celebrated by pouring into the Ohio a barrel of James River water brought from Richmond."

The pioneer coal operators of the New River Gorge area were John Nuttall, John Cooper, David T. Ansted, Colonel George W. Imboden, William N. Page, William H. Holland, and Colonel Joseph L. Beury.

The stratigraphy of New River Gorge is geologically complex. The following table gives the generally accepted classification of the rocks, with minimum and maximum thicknesses in feet of the formations designated, the former dimension prevailing in the northwest margin of Fayette County and the latter, in the southeast border:

Age.	Period.	Series. Present Surface Formation.
Quaternary	Recent.	
Paleozoic (3850-7145')	Pennsylvanian (2050-3470')	Allegheny (200-200 feet)
		Pottsville (1850-3270 feet)
		Kanawha Group (1100-1875 feet)
		New River Group (600-920 feet)
		Pocahontas Group (50-475 feet)
	Mississippian (1100-3075')	Mauch Chunk (500-2500 feet)
		Greenbrier Limestone (150-950 feet)
		Pocono Sandstones (450-625 feet)
	Devonian (700')	Catskill (700 feet)

I. C. White further divided the Pottsville Series in West Virginia as follows:

Pottsville Series.....	Upper	Beaver (Kanawha) Group.	Homewood Sandstone Stage.
			Mercer Stage.
			Connoquenessing Sandstone Stage.
	Middle	New River Group.	Nuttall Sandstone.
			Sewell Coal.
			Raleigh Sandstone.
			Beckley Coal.
			Quinnimont Sandstone and Shales
			Fire Creek Coal.
	Lower	Pocahontas Group.	Flattop Mountain Sandstone.
			Pocahontas Coals, Nos. 6, 5, 4, 3, 2 and 1, with intervening sandstone and shales.
			Pocahontas Sandstones.

A general geological section of the Pottsville Series for southern West Virginia which focuses on the stratigraphy of New River is as follows:

	Thickness. Feet.	Total. Feet.	
Coal, Gilbert, multiple-bedded, soft, gas, columnar type, not mined commercially in State; important seam in western Wyoming County and in Fayette and Nicholas.....	0 to 4	1824	
Shale, sandy, lenticular.....	0 to 6	1830	95′
Sandstone, Dotson, current-bedded, medium-grained to coarse, frequently pebbly, making great cliffs along N. & W. Ry. grade between War Eagle and Wyoming Station (formerly Dotson); same as **Bearwallow Conglomerate** of Tazewell Folio, U. S. Geological Survey; coarse, brown, and friable in Raleigh and Fayette.....	75 to 125	1955	
Coal, Douglas "A", observed only in southern McDowell.....	1 to 0	1955	
Shale, sandy, lenticular.....	50 to 10	1965	
Coal, Douglas, generally single-bedded, soft, columnar type, mined commercially at Douglas Station, McDowell County, and same as "Kidd" seam of Herberton, Fayette.....	1 to 5	1970	140′
Fire clay shale, sandy.....	0 to 5	1975	
Sandstone, Lower Dotson, heavy to current-bedded, sometimes conglomeratic, grayish-white to brown, friable, making great vertical cliffs along banks of Clear Fork and on down Guyandot River, to Justice in Wyoming County.....	50 to 100	2075	
Shale, Douglas, dark, sandy, laminated, with **marine** or **brackish-water fossil fauna** at base.....	5 to 15	2090	
Coal, Lower Douglas, multiple-bedded, soft, gas, columnar type, not mined commercially in State.....	1 to 5	2095	
Shale, gray and sandy.....	1 to 5	2100	130′
New River Group (1030 feet)			
Sandstone, Upper Nuttall, massive to heavy and current-bedded, grayish-white to brown, conglomeratic in McDowell, where it forms cliff between Panther and Douglas Station, same as **Panther Sandstone** of Wyoming-McDowell Report....	100 to 50	2150	
Shale, dark, sandy.....	0 to 7	2157	
Coal, Jaeger "B", multiple-bedded, soft, gas, columnar type, observed only on headwaters of Panther Creek, McDowell County, not mined commercially.....	0 to 3	2160	60′

	Thickness. Feet.	Total. Feet.	
Sandstone, Lower Nuttall, "Upper Iaeger", massive, medium-grained, gray to brown, making cliffs 175 feet above Tug Fork, at Iaeger, McDowell County	30 to 50	2210	
Coal, Iaeger "A", slaty and sulphurous, observed only on headwaters of Panther Creek, McDowell County	1.6 to 0	2210	50′
Shale, Upper Iaeger, dark, argillaceous, laminated, with plant fossils at base	5 to 60	2270	
Coal, Iaeger, generally double-bedded; soft, columnar, mined locally at Iaeger, McDowell, 100 feet above N. & W. Ry. grade, apparently same as Hughes Ferry Coal of Kanawha Valley	1 to 5	2275	65′
Shale, sandy	0 to 5	2280	
Sandstone, Middle Iaeger, massive, grayish-white, medium-grained to coarse, forms cliffs at Iaeger, McDowell	30 to 40	2320	
Coal, Lower Iaeger, double-bedded, soft, columnar, not mined commercially in State	0 to 2	2322	47′
Fire clay shale	0 to 3	2325	
Sandstone, Lower Iaeger, massive, gray and brown, medium-grained, micaceous	20 to 30	2355	
Shale, Lower Iaeger, dark-gray, argillaceous, laminated	20 to 35	2390	
Sandstone, Harvey Conglomerate, current-bedded to massive, conglomeratic, medium-grained to coarse, grayish-white to brown, lenticular, forms great cliffs near ridge summits, ½ mile southwest of Pando and ¾ mile N. 60° W. of English, McDowell County	125 to 25	2415	
Shale, Sandy Huff, dark-gray, argillaceous, laminated, cropping flush with N. & W. Ry. grade, just below mouth of Sandy Huff Branch, McDowell County	5 to 40	2455	
Coal, Castle, multiple-bedded, soft, columnar, irregular, not mined commercially	2 to 0	2455	133′
Sandstone, Guyandot, massive, current-bedded, often conglomeratic, medium-grained to coarse, lenticular, grayish-white, forms great cliffs in Fayette, Raleigh, Wyoming, McDowell, and Mercer Counties, and bed of New River at Gauley Station, C. & O. Ry., Fayette	0 to 75	2530	

	Thickness. Feet.	Total. Feet.	
Shale, sandy, and dark	0 to 5	2535	
Coal, Sewell "B", multiple-bedded, soft, columnar, attains minable dimensions only in southeastern Wyoming and McDowell Counties, erroneously correlated with Iaeger Coal on pp. 251-2 of Volume II(A)	0 to 5	2540	85′
Shale, sandy, flaggy, laminated	10 to 24	2564	
Coal, Sewell "A", double-bedded, soft, columnar, not mined commercially in State	0 to 1	2565	25′
Sandstone, Lower Guyandot, massive to current-bedded, medium-grained, grayish-white, lenticular, forms cliffs in Wyoming, McDowell, Raleigh, and Mercer Counties	0 to 50	2615	
Shale, Hartridge, dark, with plant fossils and in Fayette often carrying fresh- or brackish-water fossil shells	0 to 5	2620	
Coal, Sewell, generally double-bedded, soft, columnar, mined commercially in Fayette, Raleigh, and McDowell; in latter county known locally as "Davy" bed	0 to 10	2630	65′
Shale, gray, sandy, lenticular	40 to 5	2635	
Sandstone, Welch, massive to current-bedded, grayish-white, lenticular, forms great cliffs along Tug Fork between Welch and Roderfield and Dry Fork near Bradshaw, McDowell County	0 to 50	2685	
Shale, dark, argillaceous, lenticular	0 to 5	2690	
Coal, Welch, multiple-bedded, soft, columnar, mined commercially at Hemphill, Premier, Coalwood, 1 mile east of Ritter and 1.5 miles southeast of Beartown, McDowell County	0 to 5	2695	65′
Shale, gray, sandy	0 to 5	2700	
Sandstone, Upper Raleigh, heavy to current-bedded, grayish-white to brown, forms great cliffs in Fayette, Nicholas, Raleigh, Wyoming, and McDowell	50 to 75	2775	
Coal, Little Raleigh "A", not mined commercially	0 to 3	2778	
Shale, sandy, lenticular	0 to 25	2803	
Coal, Little Raleigh, multiple-bedded, soft, columnar, known as "Snake Root" bed of McDowell County, not mined commercially in State.	4 to 2	2805	110′
Shale, sandy, lenticular	15 to 5	2810	

	Thickness. Feet.	Total. Feet.	
Sandstone, Lower Raleigh, massive to current-bedded, lenticular, prominent cliff-maker in Fayette and Raleigh Counties	100 to 50	2860	
Coal, Beckley "Rider"	0 to 2	2862	
Shale, dark-gray, argillaceous, lenticular	0 to 17	2879	
Coal, Beckley, multiple-bedded, soft, columnar, mined commercially in Raleigh and McDowell Counties, same as "War Creek" bed of latter area; known as "Slab Fork" and "Winding Gulf" seams in former	0 to 10	2889	84′
Sandstone, Quinnimont, lenticular	0 to 66	2955	
Shale, Quinnimont, dark-gray, siliceous to argillaceous, laminated, lenticular	0 to 35	2990	
Coal, Fire Creek, "Quinnimont", multiple-bedded, soft, columnar, mined commercially in Fayette and Raleigh; same as locally known as "Lower Beckley" at Slab Fork, latter county	0 to 5	2995	106′
Shale, sandy, with sandstone layers	10 to 28	3023	
Coal, Little Fire Creek, multiple-bedded, soft, columnar, not mined commercially in State	0 to 2	3025	30′
Sandstone, Pineville, massive to current-bedded, forming sheer cliff almost 100 feet on Guyandot River at Pineville, Wyoming County	50 to 65	3090	
Shale, sandy	0 to 5	3095	
Coal, No. 9 Pocahontas, multiple-bedded, soft, columnar, not mined commercially in State	0 to 5	3100	75′
Shale and sandstone mixed	0 to 28	3128	
Coal, No. 8 Pocahontas, impure, soft, columnar, not mined commercially in State	0 to 2	3130	30′
Pocahontas Group (720 feet)			
Sandstone, Flattop Mountain, massive to current-bedded, medium-grained, micaceous, bluish-gray to brown, capping ridge summit of Flattop Mountain at Coaldale, Mercer County	20 to 50	3180	
Shale, Rift, dark-gray, with argillaceous and siliceous layers, cropping in bed of Big Creek at Rift, McDowell County	30 to 17	3197	
Coal, No. 7 Pocahontas, multiple-bedded, soft, columnar, not mined commercially in State	0 to 3	3200	70′
Shale, gray and sandy	0 to 5	3205	

	Thickness. Feet.	Total. Feet.	
Sandstone, Pierpont, heavy to current-bedded, medium-grained, hard, micaceous, bluish-gray to light-gray, making great cliff flush with Virginian Ry. grade ¼ mile southeast of Pierpont, Wyoming County....	40 to 60	3265	
Shale, sandy, alternating with sandstone.....	0 to 35	3300	
Shale, Royal, buff, sandy, with fresh- or brackish-water fossil fauna in Raleigh, Fayette, and Mercer Counties.....	0 to 5	3305	
Coal, No. 6 Pocahontas, multiple-bedded, soft, columnar, mined commercially in Mercer County and just below Rainelle, Fayette.....	0 to 5	3310	110′
Shale, sandy.....	0 to 5	3315	
Sandstone, Eckman, massive to current-bedded, medium-grained, buff to bluish-gray, once quarried in hill due east of Eckman, McDowell County; often cuts out the No. 5 and No. 4 Pocahontas Coals.....	40 to 67	3382	
Coal, No. 5 Pocahontas, multiple-bedded, soft, columnar, not mined commercially in State.....	0 to 5	3387	77′
Shale, sandstone, and dark shale, with plant fossils abundant.....	0 to 20	3407	
Coal, No. 4 Pocahontas, multiple-bedded, soft, columnar, mined commercially on Elkhorn Creek and Tug Fork, McDowell County.....	0 to 8	3415	28′
Shale, sandy.....	0 to 5	3420	
Sandstone, Upper Pocahontas, massive to heavy-bedded, medium-grained to coarse, quarried at Pocahontas, Virginia.....	25 to 55	3475	
Coal, No. 3 Pocahontas "Rider", not mined in State.....	2 to 0	3475	
Shale, dark, with plant fossils abundant, and fresh- or brackish-water fossil fauna reported on Piney Creek, Raleigh County.....	0 to 10	3485	
Coal, No. 3 Pocahontas, multiple-bedded, soft, columnar, mined extensively in McDowell, Mercer, and Wyoming Counties.....	0 to 15	3500	85′
Shale, gray and sandy.....	0 to 10	3510	
Sandstone, Lower Pocahontas, generally massive, medium-grained, when shaly often carries 18″ to 24″ of slaty coal (No. 2 Pocahontas "A") near middle.....	0 to 50	3560	
Shale, gray and sandy.....	0 to 8	3568	

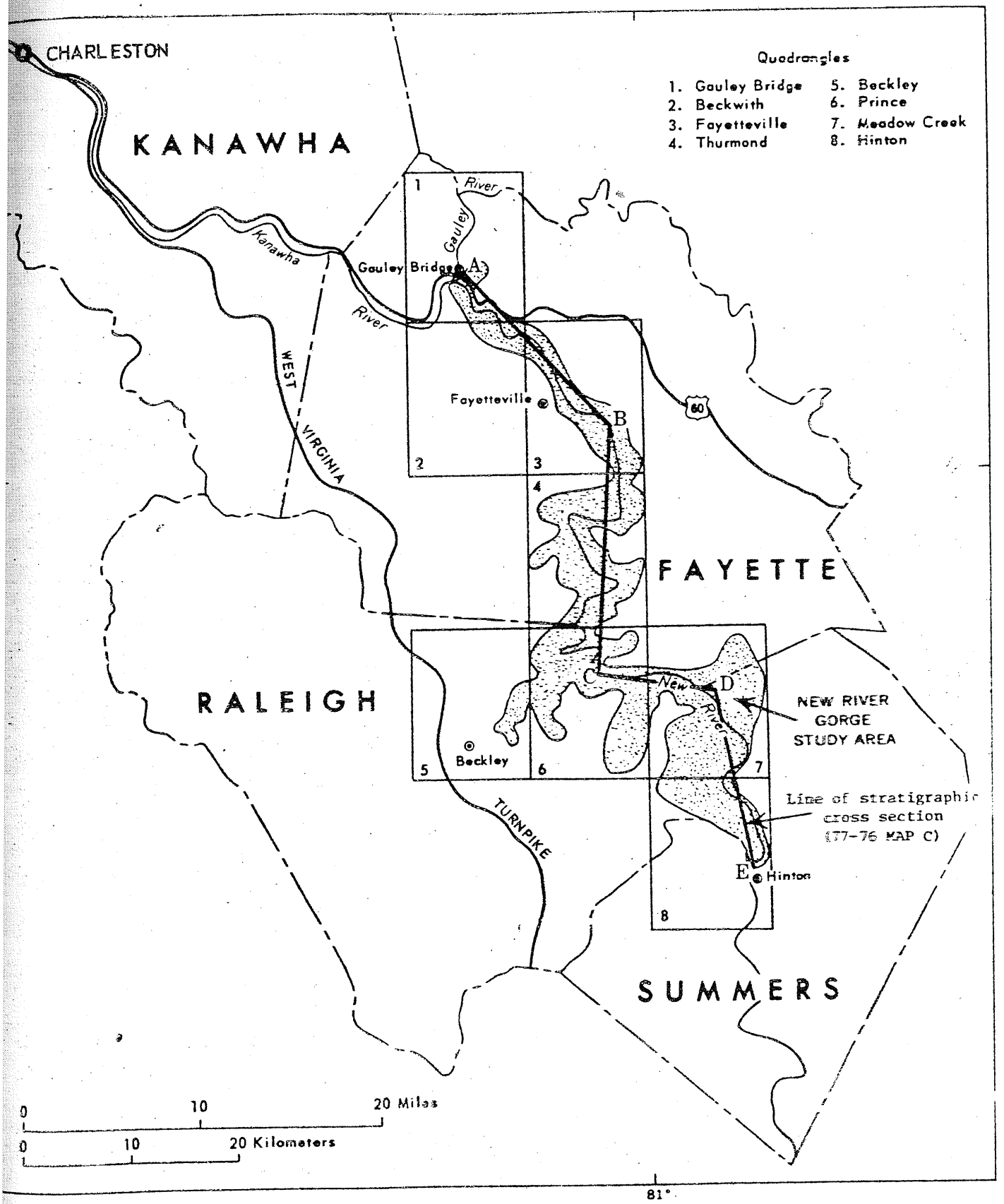
	Thickness. Feet.	Total. Feet.	
Coal, No. 2 Pocahontas, multiple-bedded, soft, columnar, not mined commercially in State.....	0 to 2	3570	70′
Shale, gray.....	0 to 5	3575	
Sandstone, Vivian, massive, bluish-gray, medium-grained, lenticular, quarried at East Vivian, McDowell County.....	0 to 29	3604	
Coal, No. 1 Pocahontas, generally single-bedded, soft, columnar, not mined in State.....	0 to 1	3605	35′
Sandstone, Landgraff, massive, buff, medium-grained, micaceous, quarried at Landgraff, McDowell County.....	0 to 20	3625	
Coal, Landgraff, soft, columnar, not mined in State.....	0 to 1	3626	21′
Sandstone, Keystone, massive, buff, medium-grained, micaceous, making cliff 8 to 10 feet above N. & W. Ry. grade at Keystone Station, McDowell County.....	0 to 23	3649	
Coal, Keystone, impure, not mined in State.....	0 to 1	3650	24′
Shale and sandstone.....	10 to 15	3665	
Shale, North Fork, black, with thin lenses (1″ to 2″) of iron ore, carrying fresh- or brackish-water fossil fauna, crops flush with N. & W. Ry. grade at North Fork, McDowell County, and in same railroad grade at Matoaka.....	5 to 10	3675	
Coal, Simmons, soft, columnar, cropping in public road just northwest of Simmons Station, Mercer County.....	0 to 1	3676	26′
Shale and sandstones, alternating....	0 to 122	3798	
Coal, Squire Jim, multiple-bedded, soft, columnar, observed only near Squire Jim, McDowell County....	0 to 2	3800	124′
Shale and sandstone to top of Mississippian, or red shales of Mauch Chunk.....	0 to 50	3850	50′

Beneath the Pottsville Series lies the Mauch Chunk Series whose features of a geological section are described below. The longest exposure of the Mauch Chunk occurs in the extreme southern point of Fayette on the northeast hillside of New River. Here about 1200 feet of Mauch Chunk outcropping occurs above the riverbed while there is probably an equal thickness lying below the riverbed on down to the top of the Greenbrier Limestone. The following is a general section of that portion of the Series exposed at this point in Fayette County:

General Section of the Mauch Chunk Series.

	Thickness. Feet.	Total. Feet.
Red and green shales, alternating with greenish-gray to brown, micaceous sandstones	200 to 375	375
Sandstone, Princeton Conglomerate, massive, grayish-white, very pebbly, making great cliffs along Meadow Creek, and quarried 0.4 mile southward from Meadow-bridge (Clute P. O.)	50 to 75	450
Shale, gray	10 to 14	464
Limestone, Terry, carrying marine fossils	1 to 1	465
Red and green shales, alternating with greenish-gray to brown, micaceous sandstones	500 to 735	1200
Interval below drainage to base of Series or top of Greenbrier Limestone, estimated	1000 to 1300	2500

Recent studies by the United States Geological Survey correspond closely with stratigraphic information developed by the West Virginia Geological and Economic Survey for New River in 1919. An "open file" series of maps includes a detailed stratigraphic cross section running lengthwise through New River Gorge. This cross section is shown in the following figure.


CHARLESTON
KANAWHA
RALEIGH
FAYETTE
SUMMERS
WEST VIRGINIA
Kanawha River
Gauley River
Gauley Bridge
Fayetteville
Beckley
Hinton
A
B
C
D
E
New River
NEW RIVER GORGE STUDY AREA
Line of stratigraphic cross section (77-76 MAP C)
TURNPIKE
60
Quadrangles
1. Gauley Bridge
2. Beckwith
3. Fayetteville
4. Thurmond
5. Beckley
6. Prince
7. Meadow Creek
8. Hinton
0 10 20 Miles
0 10 20 Kilometers
81°

INDEX MAP

The major "formations" and their respective strata are given the following descriptions by the US Geological Survey.

About 4,200 feet of sedimentary rocks of Late Mississippian to Middle Pennsylvanian age crop out in the New River Gorge Area. The basal 1900 feet of the exposed beds represent near shore, swamp, intertidal, and marine deposits that are assigned to the Bluefield and Hinton Formations and to the Princeton Sandstone of Late Mississippian age and to the Bluestone Formation of Late Mississippian and Early Pennsylvanian age. Outcrops of these formations are principally in the southeastern part of the area and, to a limited extent, northwestward along the lower valley slopes bordering the New River and its tributaries in the central part of the area. The remainder of the exposed stratigraphic section consists mostly of continental coal-bearing rocks of the Pocahontas, New River, and Kanawha Formations of Early to Middle Pennsylvanian age. These rocks cap hilltops in the southern part of the area and, as a result of a northwesterly regional dip, comprise the entire exposed section in the northern part.

Bluefield Formation- The oldest exposed rocks in the Gorge area are grayish-red, greenish-gray, and gray calcareous shale that occur in the uppermost part of the Bluefield Formation. A maximum of 25 feet of the formation is exposed and possibly another 900 feet of similar lithology interbedded with lesser amounts of sandstone, siltstone, and limestone are present in the subsurface.

Hinton Formation- Outcrops of the Hinton Formation are dominated by grayish-red, partly calcareous shale and siltstone. Also present are several intercalcated sandstone beds, minor amounts of medium-gray and greenish-gray shale, fossiliferous limestone and calcareous shale, and a few thin beds of coal or carbonaceous shale underlain by rooted underclay. The Hinton Formation ranges from about 950 to 1150 feet in thickness in the southern part of the Gorge area.

The Stony Gap Member at the base of the formation is commonly quartzose, highly resistant, and about 100 feet thick, including as much as 25 feet of grayish-red or greenish-gray shale. This member forms prominent cliffs and rapids along New River near Hinton. An abandoned quarry in the Hinton quadrangle appears to have been the source of riprap for road construction.

The Hinton Formation also includes the thickest and most widespread limestone bed in the Gorge area- the Little Stone Gap Member or Avis Limestone of Reger (1926). It consists of as much as 55 feet of argillaceous limestone and calcareous shale and contains abundant marine fossils including brachiopods, pelecypods, gastropods, and bryozoans.

Bluestone Formation- The Bluestone formation includes six widely recognized members that total about 650 feet in thickness. The Pride Shale Member, at the base of the formation ranges from about 40 to 120 feet in thickness and consists principally of dark-gray evenly bedded shale that grades locally to silty shale or interlaminated siltstone and shale. Basal beds of the member may include partly calcareous greenish-gray and grayish-red shale. The overlying dark-gray shale beds commonly contain pyrite and ironstone nodules and lenses. Marine fossils including brachiopods, pelecypods, gastropods, and cephalopods occur locally in the member.

The overlying Glady Fork Sandstone Member varies from silty ripple-bedded sandstone to coarse conglomeratic sandstone. It commonly consists of light-gray, fine- to coarse-grained, thin-bedded to massive sandstone. Conglomerate is diverse in composition but consists primarily of well-rounded to angular fragments of quartz, shale, siltstone, limestone, chert, and siderite. The member ranges from 0-100 feet or more in thickness.

The gray member of the Bluestone Formation is a wedge of interbedded shale, sandstone, and siltstone with a few thin beds of underclay and coal. It is restricted to the southeastern part of the New River Gorge area, where it attains a maximum thickness of about 200 feet.

The red member of the Bluestone Formation is principally grayish-red partly calcareous shale, siltstone, and sandstone. Also present are greenish-gray to medium gray shale, siltstone, sandstone, and a few thin beds of argillaceous limestone, rooted underclay, and carbonaceous shale. The red member is as much as 250 feet thick in the southeastern part of the Gorge area and thins northwestward to about 20 feet. The grayish-red beds in this member wedge out northward along the New River in the Thurmond quadrangle.

The Bramwell Member consists predominantly of medium- to medium-dark-gray calcareous shale and siltstone which coarsen upward and, in places, grade to very fine- to fine-grained ripple-bedded sandstone. A basal bed of black carbonaceous shale contains abundant ostracods and pelecypods; overlying beds of the member contain brachiopods and pelecypods. The member was identified only in the Meadow Creek and Hinton quadrangles where it is as much as 50 feet thick.

The upper member of the Bluestone consists of shale and siltstone that are typically grayish-red and greenish-gray. It intertongues and grades laterally with the lower sandstone member of the Pocahontas Formation and, because of this relationship, the upper member is classified as Pennsylvanian in age. A persistent bed of light greenish-gray, sparsely rooted, nonbedded claystone as much as 5 feet thick occurs at the top of the upper member.

Pocahontas Formation- In contrast to the abundance of variegated, calcareous beds in the Bluestone Formation, the Pocahontas Formation is a coal-bearing sequence consisting of interbedded sandstone, siltstone, shale, and underclay. Of these, sandstone is most abundant and constitutes about 70 % of the formation; siltstone, shale, and underclay total 28 %, and coal, the remaining 2 %. Plant fossils, including stems, leaves, and roots, occur throughout the formation, and fresh- or brackish-water invertebrate fossils are present in a few beds. From a maximum thickness of about 400 feet in the southern part of the Gorge area, the formation thins northwestward and wedges out in the subsurface in the Gauley Bridge quadrangle. Coal beds in the Pocahontas formation, including the Pocahontas Nos. 2, 3, and 6 zone, are as much as 6 feet thick and relatively continuous in the southern part of the Gorge area but become thinner and more discontinuous northwestward with the general northwestward thinning of the formation.

New River Formation- In the New River Gorge area, the Pocahontas Formation is unconformably overlain by the New River Formation. This unconformity occurs at the base of the Pineville Sandstone Member of the New River Formation in the Gorge area and coincides with the widespread unconformity that separates Mississippian rocks from Pennsylvanian strata north of the area underlain by the Pocahontas Formation.

The New River Formation ranges from 700 feet in thickness along the New River in western Fayette County to about 1000 feet in thickness in the southeasternmost outcrops. It is a coal-bearing sequence of sandstone, siltstone, shale, and underclay that is lithically similar to the Pocahontas Formation except for the presence of thicker and more widespread quartz-pebble conglomerate and quartzose sandstone. Quartzose conglomeratic sandstone predominates in the northwesternmost outcrops of the formation and forms precipitous cliffs along the New River. These sandstone units, including the Nuttall and Raleigh Sandstone Members, become less conspicuous southeastward as a result of lateral gradation in part to non-resistant, micaceous, and feldspathic sandstone with a relatively low quartz content of 50 to 60 percent. The Nuttall Sandstone Member is the uppermost member of the New River Formation, and the contact with the overlying Kanawha Formation of the Middle Pennsylvanian Series is placed at the base of a thin coal bed that overlies the Nuttall Sandstone Member. Commonly, a few feet of underclay, shale, or siltstone occur between the sandstone and the coal. The New River Formation contains the principal and most widely mined coal beds- including the Fire Creek, Beckley, and Sewell- in the Gorge area. Plant fossils occur in most beds of the formation and invertebrate fossils such as pelecypods, ostracodes, and brachiopods are present locally.

Kanawha Formation- The Kanawha Formation is confined to the northern part of the Gorge area, where about 900 feet of beds in the lower part of the formation conformably overlie the New River Formation. About 65 % of the formation consists of relatively nonresistant shale, siltstone, and underclay. Sandstone comprises about 33 %, and it is less quartzose and less resistant to weathering than the cliff-forming sandstones of the New River Formation. The Kanawha Formation contains many of the highly productive coal beds of West Virginia, and in the Gorge area coal comprises about 2 % of the formation. The coal is distributed in 12 beds, of which four- the Eagle, Powellton, No. 2 Gas, and Hernshaw(?)- are thick enough to contain coal resources. Fossil plants, including leaves, roots, and stems, are common in many beds and fresh-water invertebrate fossils occur in the roof shale of the Gilbert (?) coal bed.

Surficial Deposits- The bedrock in the Gorge is covered locally by surficial deposits, including alluvium in the flood plains of the major rivers and tributaries and colluvium in sporadic accumulations on the lower valley slopes. Of these, only the larger alluvial deposits are mapped, and these consist of unconsolidated boulders and gravel that commonly grade upward to poorly sorted sand and silt. Alluvium is a source of gravel at one locality along the New River in the Prince quadrangle.

The above descriptions of the major geologic formations as included in the US Geological Survey "open file" are quite technical. Less technical descriptions are included in the detailed county reports of Fayette County and Raleigh and western Summers Counties by the WV Geological Survey and the two US Geological Survey publications on the "Availability of Low-Sulfur Coal in Fayette County (Hadley 1966) and Raleigh County (Englund 1968).

Non-metallic minerals which occur in the New River Gorge are sandstone, shale, limestone, sand and gravel. All of these are abundant but are more common outside the boundaries of the New River Gorge National River.

Information on descriptions of coal seams, coal analysis (chemical and structural) and coal reserves is well documented. The following tables reflect these data.

The generalized geologic column for oil and gas in West Virginia on page 34 indicates the possibility of occurrence in any sand of the Pottsville Series, the Maxton (Princeton Conglomerate??) and Little Lime stratas of the Mauch Chunk Series, the Big Lime of the Greenbrier Limestone and the Big Injum Sand strata of the Pocono Sandstones. These above strata occur in, near or under New River. From a practical viewpoint, Krebs stated that it is possible that oil and gas may be found in the lower sands when thoroughly prospected but there is very little probability that they will have commercial quantities. Similarly, an April 1962 newsletter from the WV Geological Survey indicated no productive oil and gas fields in the New River Gorge.

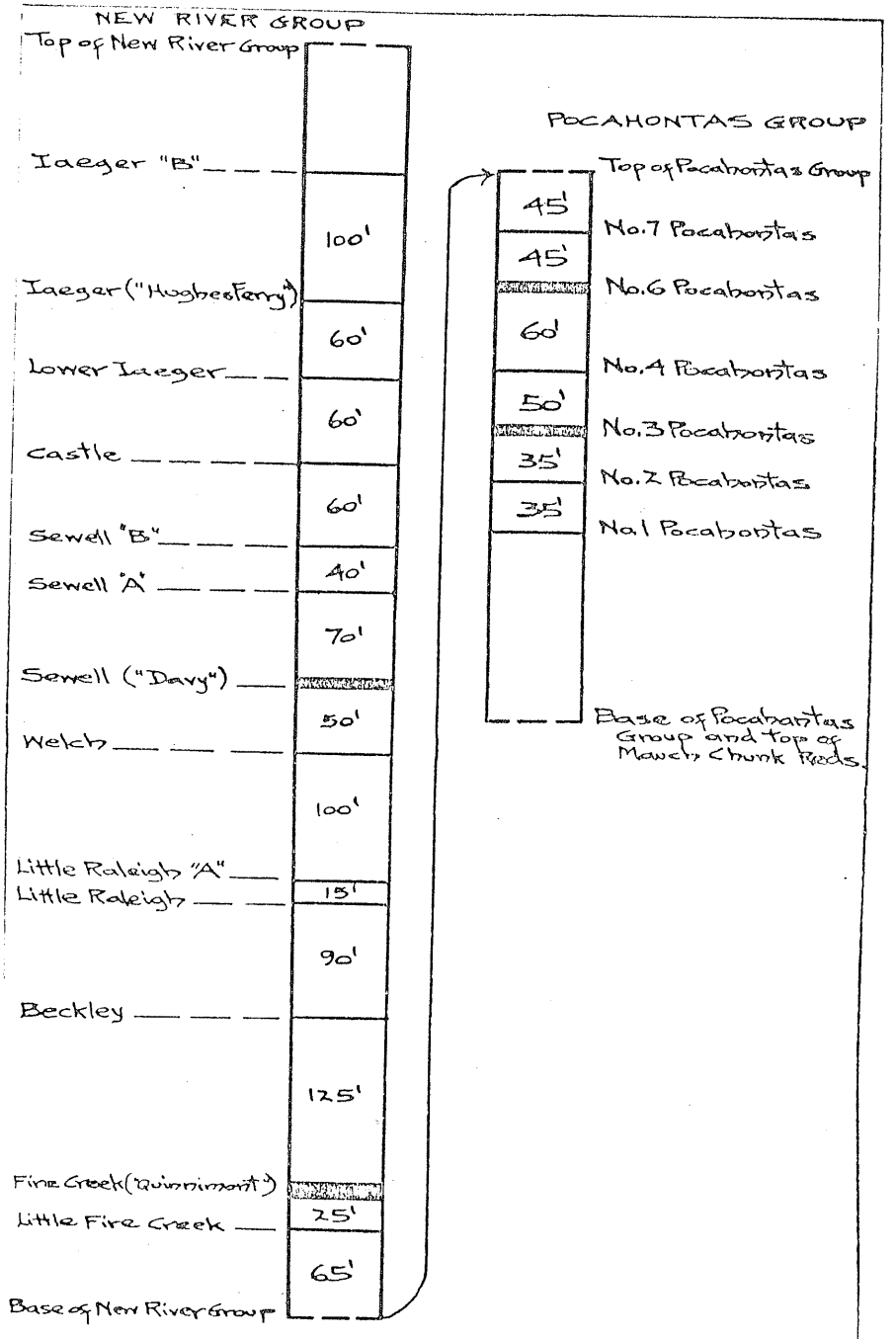
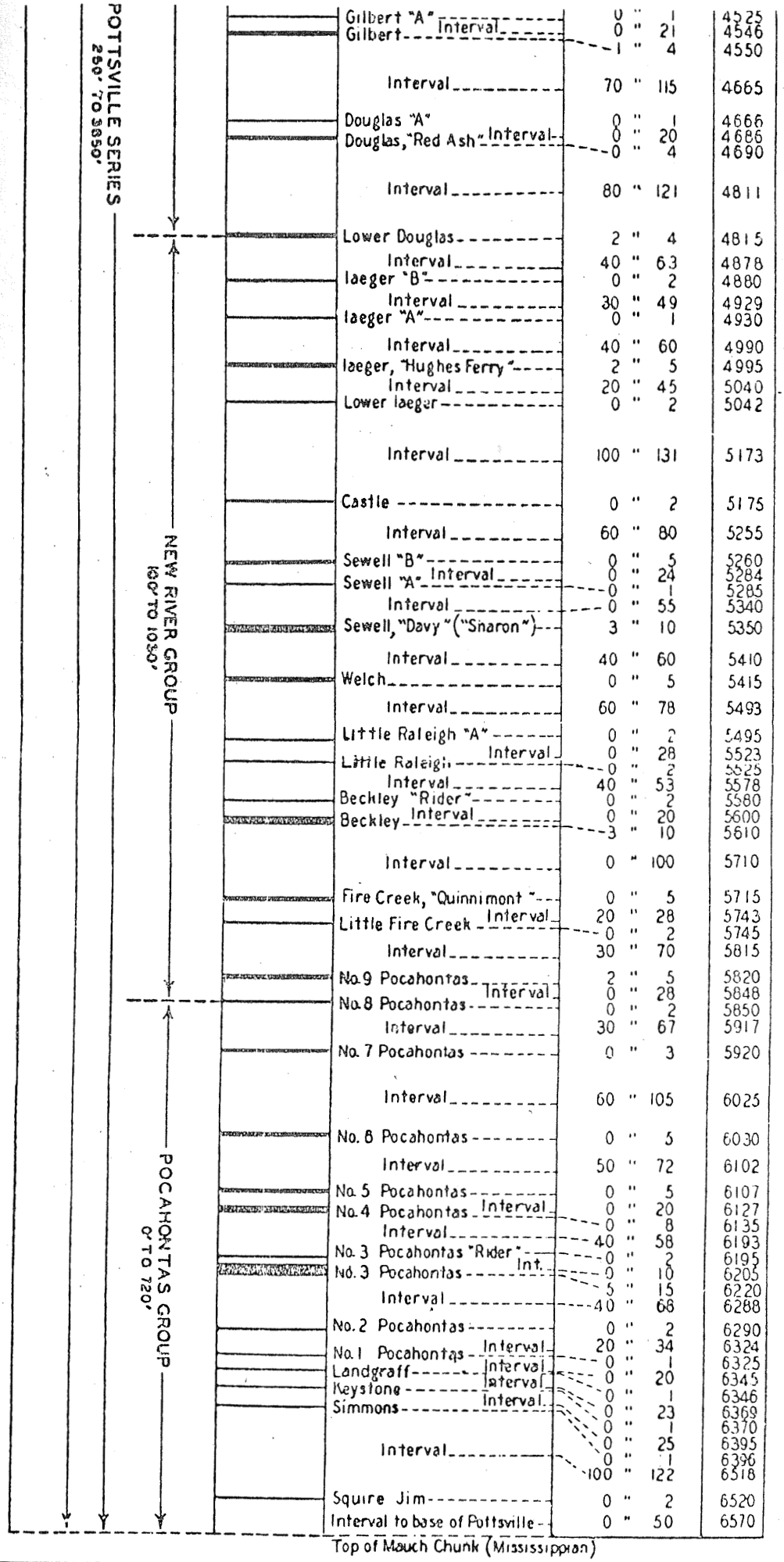


Figure 4.— Showing Approximate Intervals in Feet Between Coals of New River and Pocahontas Groups in Fayette County, W. Va.



	0 " 1		4525
	0 " 21		4546
	1 " 4		4550
	70 " 115		4665
	0 " 1		4666
	0 " 20		4686
	0 " 4		4690
	80 " 121		4811
	2 " 4		4815
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	0 " 1		5285
	0 " 55		5340
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	0 " 5		5415
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	0 " 10		6205
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	0 " 1		6370
	0 " 25		6395
	0 " 1		6396
	100 " 122		6518
	0 " 2		6520
	0 " 50		6570

FIGURE
SHOWING
BITUMINOUS COAL BEDS
IN
WEST VIRGINIA
COMPILED AND REVISED TO DATE - MAY 1, 1939
BY
R. C. TUCKER,
ASST. STATE GEOLOGIST
WEST VIRGINIA GEOLOGICAL SURVEY

Estimated Original and Remaining Coal Resources of the Proposed National Park Area of the New River Gorge, Fayetteville, Raleigh, and Summers Counties, West Virginia.

[In thousands of short tons. Covered by less than 1,000 feet. As of January 1, 1977.]

FORMATION	COAL BED	ORIGINAL RESOURCES																MINED AND LOST IN MINING	TOTAL REMAINING RESOURCES
		MEASURED				INDICATED				INFERRED			TOTAL						
		In beds 14-28 inches thick	In beds 28-42 inches thick	In beds more than 42 inches thick	Total	In beds 14-28 inches thick	In beds 28-42 inches thick	In beds more than 42 inches thick	Total	In beds 14-28 inches thick	In beds 28-42 inches thick	Total	In beds 14-28 inches thick	In beds 28-42 inches thick	In beds more than 42 inches thick	Total		
Cauley Bridge Quadrangle																			
Kanawha	Hernshaw (?)	------	------	------	------	------	------	------	------	331	------	331	331	------	------	331	---------		331
	No. 2 Gas	------	1,496	738	2,234	------	------	------	------	------	------	------	------	1,496	738	2,234	1,778		456
	Powellton	------	1,709	236	1,945	------	222	412	634	------	------	------	------	1,931	648	2,579	20		2,559
	Eagle	3	------	------	3	3	------	------	3	1,300	------	1,300	1,306	------	------	1,306	---------		1,306
New River	Little Raleigh	359	------	------	359	1,560	------	------	1,560	557	------	557	2,476	------	------	2,476	---------		2,476
	Fire Creek	------	562	------	562	------	2,344	------	2,344	1,537	------	1,537	1,537	2,906	------	4,443	---------		4,443
	Total	362	3,767	974	5,103	1,563	2,566	412	4,541	3,725	------	3,725	5,650	6,332	1,386	13,369	1,798		11,571
Beckwith Quadrangle																			
Kanawha	Powellton	------	------	------	------	------	22	------	22	------	------	------	------	22	------	22	---------		22
New River	Sewell	199	86	------	285	------	------	------	------	------	------	------	199	86	------	285	---------		285
	Little Raleigh	------	------	------	------	140	------	------	140	874	------	874	1,014	------	------	1,014	---------		1,014
	Fire Creek	------	------	------	------	------	209	------	209	2,961	------	2,961	2,961	209	------	3,170	---------		3,170
	Total	199	86	------	285	140	231	------	371	3,835	------	3,835	4,174	317	------	4,491	---------		4,491
Fayetteville Quadrangle																			
New River	Sewell	1,322	24,613	7,240	33,175	------	------	------	------	------	------	------	1,322	24,613	7,240	33,175	27,184		5,991
	Little Raleigh	523	126	------	649	1,567	31	------	1,598	326	------	326	2,416	157	------	2,573	---------		2,573
	Fire Creek	698	------	------	698	2,641	------	------	2,641	3,835	------	3,835	7,174	------	------	7,174	---------		7,174
Pocahontas	Pocahontas No. 6 Zone	144	------	------	144	619	------	------	619	467	------	467	1,230	------	------	1,230	---------		1,230
	Total	2,687	24,739	7,240	34,666	4,827	31	------	4,858	4,628	------	4,628	12,142	24,770	7,240	44,152	27,184		16,968

(continued)

Thurmond Quadrangle

New River	Hughes Ferry(?)	634	------	------	634	248	------	------	248	356	------	356	1,238	------	------	1,238	312	926
	Sewell	------	------	22,458	22,458	------	------	------	------	------	------	------	------	------	22,458	22,458	22,458	----------
	Beckley	527	------	------	527	572	------	------	572	------	------	------	1,099	------	------	1,099	----------	1,099
	Fire Creek Rider	520	------	------	520	528	------	------	528	------	------	------	1,048	------	------	1,048	----------	1,048
	Fire Creek	9,119	19,915	12,874	41,908	6,100	------	------	6,100	------	------	------	15,219	19,915	12,874	48,008	25,148	22,860
Pocahontas	Pocahontas No. 6 Zone	1,333	------	------	1,333	3,105	------	------	3,105	1,799	------	1,799	6,237	------	------	6,237	----------	6,237
	Total	12,133	19,915	35,332	67,380	10,553	------	------	10,553	2,155	------	2,155	24,841	19,915	35,332	80,088	47,918	32,170

Beckley Quadrangle

New River	Beckley	------	71	------	71	8	------	------	8	------	------	------	8	71	------	79	71	8
	Fire Creek	76	158	------	234	15	------	------	15	------	------	------	91	158	------	249	86	163
Pocahontas	Pocahontas No. 6 Zone	148	------	------	148	364	------	------	364	------	------	------	512	------	------	512	----------	512
	Pocahontas No. 3	122	150	765	1,037	234	267	1,316	1,817	587	------	587	943	417	2,081	3,441	----------	3,441
	Total	346	379	765	1,490	621	267	1,316	2,204	587	------	587	1,554	646	2,081	4,281	157	4,124

Prince Quadrangle

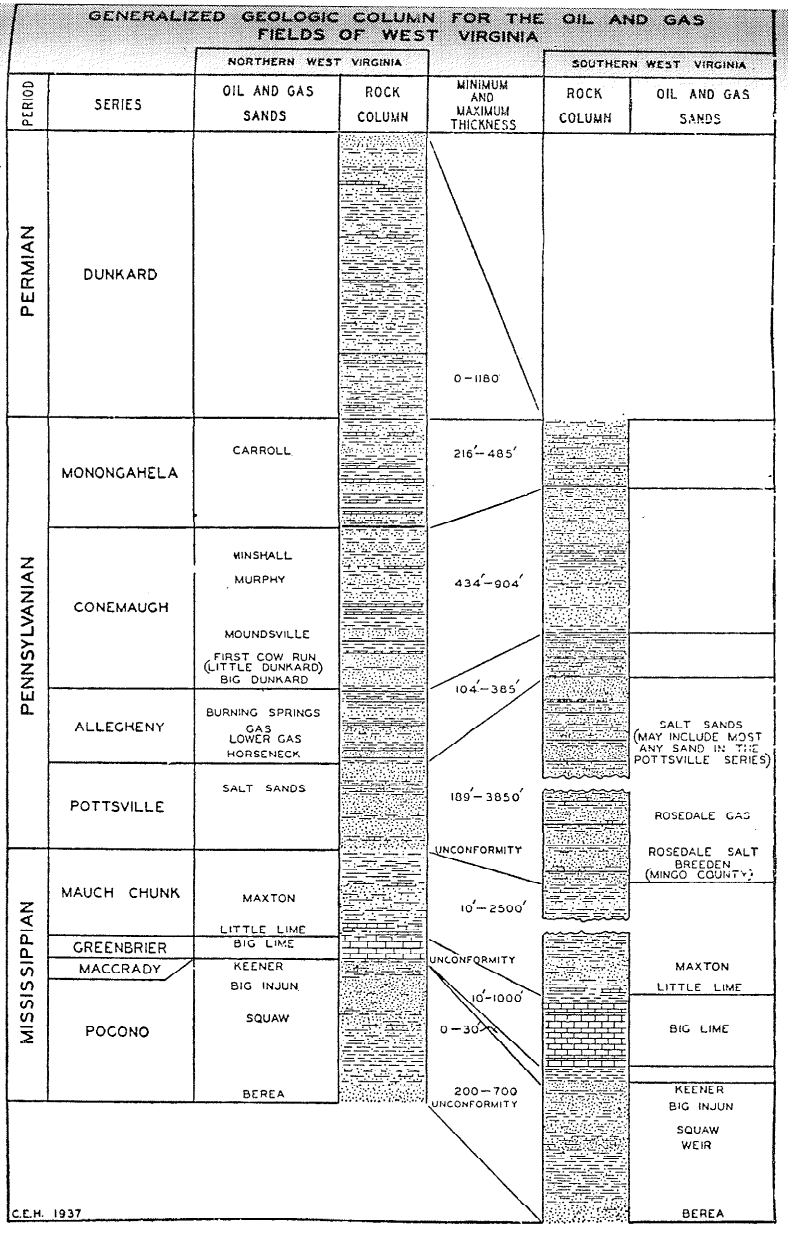
New River	Sewell	------	533	------	533	------	------	------	------	------	------	------	------	533	------	533	533	----------
	Little Raleigh	171	------	------	171	1,227	------	------	1,227	1,256	------	1,256	2,654	------	------	2,654	----------	2,654
	Beckley	991	1,237	223	2,451	2,843	2,267	------	5,110	519	98	617	4,353	3,602	223	8,178	454	7,724
	Fire Creek Rider	66	70	35	171	------	------	------	------	------	------	------	66	70	35	171	171	----------
	Fire Creek	3,641	10,573	621	14,835	1,038	800	------	1,838	128	------	128	4,807	11,373	621	16,801	9,729	7,072
Pocahontas	Pocahontas No. 6 Zone	947	154	------	1,101	1,816	------	------	1,816	1,098	------	1,098	3,861	154	------	4,015	----------	4,015
	Pocahontas No. 3	749	1,702	1,551	4,002	6,687	5,736	4,936	17,359	4,539	911	5,450	11,975	8,349	6,487	26,811	----------	26,811
	Total	6,565	14,269	2,430	23,264	13,611	8,803	4,936	27,350	7,540	1,009	8,549	27,716	24,081	7,366	59,163	10,887	48,276

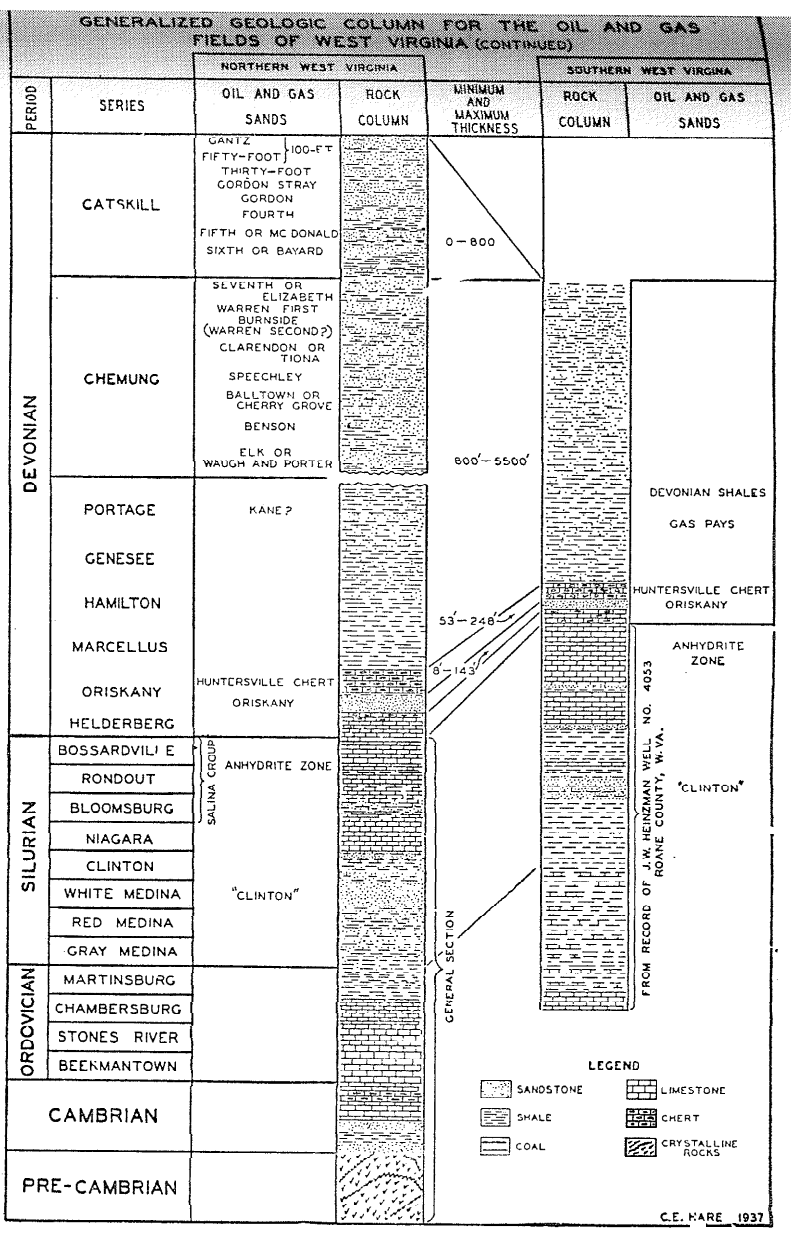
Meadow Creek Quadrangle

New River	Fire Creek	240	------	------	240	536	------	------	536	------	------	------	776	------	------	776	----------	776
Pocahontas	Pocahontas No. 6 Zone	922	650	2,087	3,659	184	50	131	365	------	------	------	1,106	700	2,218	4,024	734	3,290
	Pocahontas No. 3	1,566	1,651	8,030	11,247	4,558	2,345	4,967	11,870	188	------	188	6,312	3,996	12,997	23,305	2,727	20,578
	Pocahontas No. 2	267	119	------	386	363	1,321	------	1,684	1,186	644	1,830	1,816	2,084	------	3,900	----------	3,900
	Total	2,995	2,420	10,117	15,532	5,641	3,716	5,098	14,455	1,374	644	2,018	10,010	6,780	15,215	32,005	3,461	28,544

Hinton Quadrangle

Pocahontas	Pocahontas No. 3	70	418	------	488	266	637	------	903	12	7	19	348	1,062	------	1,410	----------	1,410
	Pocahontas No. 2	1,246	787	------	2,033	919	894	------	1,813	131	------	131	2,296	1,681	------	3,977	127	3,850
	Total	1,316	1,205	------	2,521	1,185	1,531	------	2,716	143	7	150	2,644	2,743	------	5,387	127	5,260
	Grand Total	26,603	66,780	56,858	150,241	38,141	17,145	11,762	67,047	23,987	1,660	25,647	88,731	85,585	68,620	242,936	91,532	151,404





Geologic Column—Courtesy West Virginia Geological Survey

This economic geology and stratigraphy summary utilized the following references as the primary sources of information;

1. Englund, Kenneth J. 1968. Availability of Low-Sulfur Coal in Raleigh County, West Virginia.

2. Fisher, Howell. 1868. Description of Great Falls of New River and Coal Lands Adjacent.

3. Hadley, Donald G. 1966. Availability of Low-Sulfur Coal in Fayette County, West Virginia.

4. Hennen, Ray V., et. al. 1919. Fayette County-Detailed County Report.

5. Krebs, Charles E. and D. D. Teets, Jr. 1916. Raleigh County and Western Portions of Mercer and Summers Counties- Detailed County Report.

6. Rogers, William Barton. 1884. A Reprint of Annual Reports and Other Papers of the Geology of the Virginias.

7. US Geologic Survey. 1976 and 1977. Open File Report of -77-76.

The major soil-association in the New River Gorge Area is the Steep Rock Land-Dekalb-Gilpin Association. The New River has cut through sandstone, siltstone, and shale strata and has formed a gorge that has very steep sides, and it ranges from 500 feet in depth from the lower end to nearly 1000 feet in some places. Vertical sandstone cliffs 20 to 25 feet high are common, and large stones have accumulated at the base of the cliffs.

About 65% of this is Steep rock land, 10% Dekalb soils, and 10% is Gilpin soils. The remaining 15% is minor soils.

The Steep rock land consists of the sandstone cliffs and the accumulation of large stones at their base.

Dekalb soils are mostly very steep and very stony. They generally have moderately coarse textured material throughout the profile. Their subsoil is yellowish brown or strong brown and it is channery or very channery. Dekalb soils formed in material weathered from acid sandstone.

Gilpin soils are mostly very steep and very stony. They have a medium-textured surface layer and a yellowish-brown or strong-brown, moderately fine textured or medium textured subsoil that is generally channery. Gilpin soils formed in acid material weathered from siltstone, shale, and soft sandstone. They have finer textured subsoil and contain fewer channery fragments than Dekalb soils.

Minor soils of this association are the Calvin and Gipin very stony soils on lower mountainsides; the Ernest and Meckesville soils on foot slopes; and the Ashton, Chavies, Landes, Philo, and Pope soils on flood plains.

Most of this association is wooded. Some commercial timber is harvested, but is difficult because of the rock cliffs and very steep slopes.

Most all of the land in the gorge and some on the flats and uplands above have severe limitations to building construction, sewage disposal and recreational development. The soils suited to development occurr in small scattered areas on the uplands. A little more detailed discussion of the individual

soil series occurring in the area their land capabilities is given as follows:

Steep Rock Land - Steep rock land consists of very steep massive outcropping sandstone ledges and vertical sandstone cliffs 10 to 50 feet or more high. Very large boulders have accumulated at the base of many of the cliffs. This land poses severe limitations to any or all kinds of development, including hiking trails or horse trails. It is generally not suited for the commercial production of trees. It is best suited for watershed and as a wildlife habitat.

Dekalb Series - The Dekalb series consists of moderately deep, well drained soils on ridgetops, hillsides, and mountainsides throughout the New River area. Slopes range from 3 to 70 percent, but are mostly more than 40 percent. Most of the Dekalb soils occurring in the area are stony-Dekalbs. Dekalb soils have low to moderate available moisture capacity and rapid permeability. Natural fertility is low. The Dekalb soils are fair to good for trees and most of the acreage in the area is wooded. Upland oaks and yellow poplar grow best.

Most of the soils in the study area are poorly suited to crop production and pose severe limitations for buildings and sewage disposal. Some of the areas pose slight limitations to picnic and camping areas. Most all are severe for playground development.

Calvin Series - The calvin series consists of moderately deep to well drained soils on the uplands and steep soils on the lower parts of mountainsides. Slopes range from 10 to 70 percent, but slopes of more than 40 percent are dominant. Most of the Calvin soils are stony. They have moderate available moisture capacity and moderately rapid permeability. Natural fertility is moderate.

Most areas of the Calvin soils are poorly suited to crops, hay, and pasture because they are too steep. They are fairly suited to poorly suited for wood production. The Calvin soils pose severe limitations to building construction, sewage disposal, to moderate limitations for camp construction on the less steep soil units. Some of the less steep areas in the study area are suited to development of picnic areas, trails, and camps.

Gilpin Series - The Gilpin series consists of moderately deep, well drained soils on rolling shale ridges and mountainsides in scattered parts of the area. Slopes range from 3 to 65 percent. Gilpin soils have moderate to high available moisture capacity and moderate permeability. Natural fertility is moderate.

Areas of the less sloping, nonstony Gilpin soils are suited to crops, hay and pasture. The majority of Gilpin soils in the area consist of the steep and stony soils which are limited to growing trees. They are well suited to oaks, yellow poplar and associated species.

All Gilpin soils pose severe limitations to buildings, and sewage disposal. Some of the less steep and/or stony soils pose only slight to moderate limitations for camps, picnic areas, and trails. Very few areas would be suited for playgrounds.

Cookport Series - The Cookport series consists of deep, moderately well drained soils on ridgetops and benches. These soils formed in acid material weathered from sandstone and some shale and some siltstone. Slopes from 2 to 8 percent occurr in the area. There is only one Cookport soil occurring in the lower or northern area of the New River Gorge area. The soil occurs in small scattered areas. Cookport soils have moderate to high available water capacity. They have moderately slow permeability in the fragipan and moderately high above the fragipan. The water table is moderately high in winter and early spring. Seeps are common; natural fertility is low.

These soils are suited to hay, crops and pasture. They have severe limitations for certain kinds of sewage treatment or disposal facilities and moderate limitations for others. The limitations to building construction, camp sites, picnic ares and trails are moderate to slight. Limitations to playgrounds also moderate.

Clymer Series - The Clymer series consists of deep well-drained soils on mountaintops and broad benches in the central and lower areas of the New River Gorge Area. These soils formed in acid material weathered from sandstone. Slopes are 3 to 20 percent. Clymer soils have moderate to high available moisture capacity and moderate to moderately rapid permeability. Natural fertility is generally low. These soils are suited to crops,

hay, and pasture. The soils on 3 to 10 percent slopes pose only moderate limitations to building construction and sewage disposal. Also they pose moderate to only slight limitations for camps, picnic areas, trails, and playgrounds. Those with a greater degree of slope pose severe limitations to sewage disposal and playgrounds.

Ernest Series - The Ernest series consists of deep, moderately well drained soils on foot slopes. These soils formed in the acid colluvial material from soils on uplands that are underlain by shale, siltstone, and sandstone. Both stony and nonstony units occur in the area, mostly in narrow bands along the river. Slopes range from 3 to 40 percent. Ernest soils have a moderate to high available moisture capacity. They have moderately slow permeability in the fragipan and moderate above the fragipan. The water table is moderately high in the winter ane early spring.

These soils pose severe limitations to sewage disposal by disposal fields and moderate limitations for impoundments and sewage lagoons. They pose only moderate limitations to building construction, camps, picnic , playgrounds and trails.

Meckesville Series - The Meckesville series consists of deep, well-drained soils on foot slopes and around heads of streams in small scattered areas. These soils formed in colluvium from soils on uplands that are underlain by red and gray shale and siltstone. Slopes range from 3 to 40 percent. These soils have high available moisture capacity. They have moderately slow permeability in the fragipan and moderate permeability above.

Areas of nonstony soils are suited to crops, hay and pasture. Most of the stony areas are wooded. The less steep soils pose only moderate limitations to sewage disposal and buildings. The limitations to camps, picnic areas, playgrounds, trails and other development are only slight to moderate.

Pope Series - The Pope series consists of deep, well-drained soils on flood plains. These soils formed in acid alluvial material washed from soils on uplands that are underlain by sandstone, siltstone and shale. They are flooded at occasional to frequent intervals. Slopes range from 0 to 5 percent.

Pope soils have severe limitations to most kinds of development

due to flooding hazards. However picnic areas, playgrounds and trails could be put in.

Philo Series - The Philo series consists of deep, moderately drained soils on flood plains. Slopes range from 0 to 3 percent. These soils formed in acid alluvial material washed from soils on uplands, that are underlain by sandstone, siltstone and shale. They are flooded at occasional to frequent intervals. These soils are easy to work and are suited to crops, hay, and pasture. They have a high available moisture capacity, and moderate to moderately slow permeability.

Philo soils pose severe limitations to most all development due to flooding hazards.

Ashton Series - The Ashton series consists of deep, well-drained soils on high positions of the flood plain along the New River. These soils formed in alluvium washed from soils on the uplands that are mostly underlain by limestone. They flood only when flood waters are at their highest. Slopes range from 0 to 5 percent. Ashton soils have a high available moisture capacity and moderate permeability. Natural fertility is high. Ashton soils are easy to work and suited to crops, hay and pasture.

These soils pose severe limitations to buildings due to flooding hazard. However, they pose only slight to moderate limitations to picnic areas, trails, playgrounds and camps.

Chavies Series - The Chavies series consists of deep, well-drained soils on high positions of the flood plains along New River. They formed in acid alluvial material washed from soils on uplands that are underlain by sandstone, siltstone, and shale. Chavies soils are slightly droughty and are subject to infrequent overflow. Slopes range from 0 to 5 percent. Chavies soils have moderate to high available moisture capacity, and moderately rapid permeability. Natural fertility is high.

These soils are well suited to crops, hay and pasture. Limitations to buildings could be severe due to possible floods, as well as for sewage disposal. Limitations to recreational development is slight to moderate.

Landes Series - The Landes series consists of deep, well-

drained soils on flood plains along New River. These soils formed in mixed material washed from soils on uplands underlain by sandstone, shale, and limestone. They are occasionally flooded. Slopes range from 0 to 3 percent. Landes soils have moderate to high available moisture capacity and moderately rapid permeability. Natural fertility is moderate to high.

These soils are easy to work and are suited to crops, hay and pasture. Crops could be damaged due to flooding. Limitations to buildings, sewage disposal and camp areas are severe due to flooding. Limitations to picnic areas, trails and playgrounds are slight to moderate.

This summary contains information from the following source:

1. Gorman, John L. and Lester E. Espy. 1975. Soil Survey of Fayette and Raleigh Counties, West Virginia.

PALEONTOLOGY

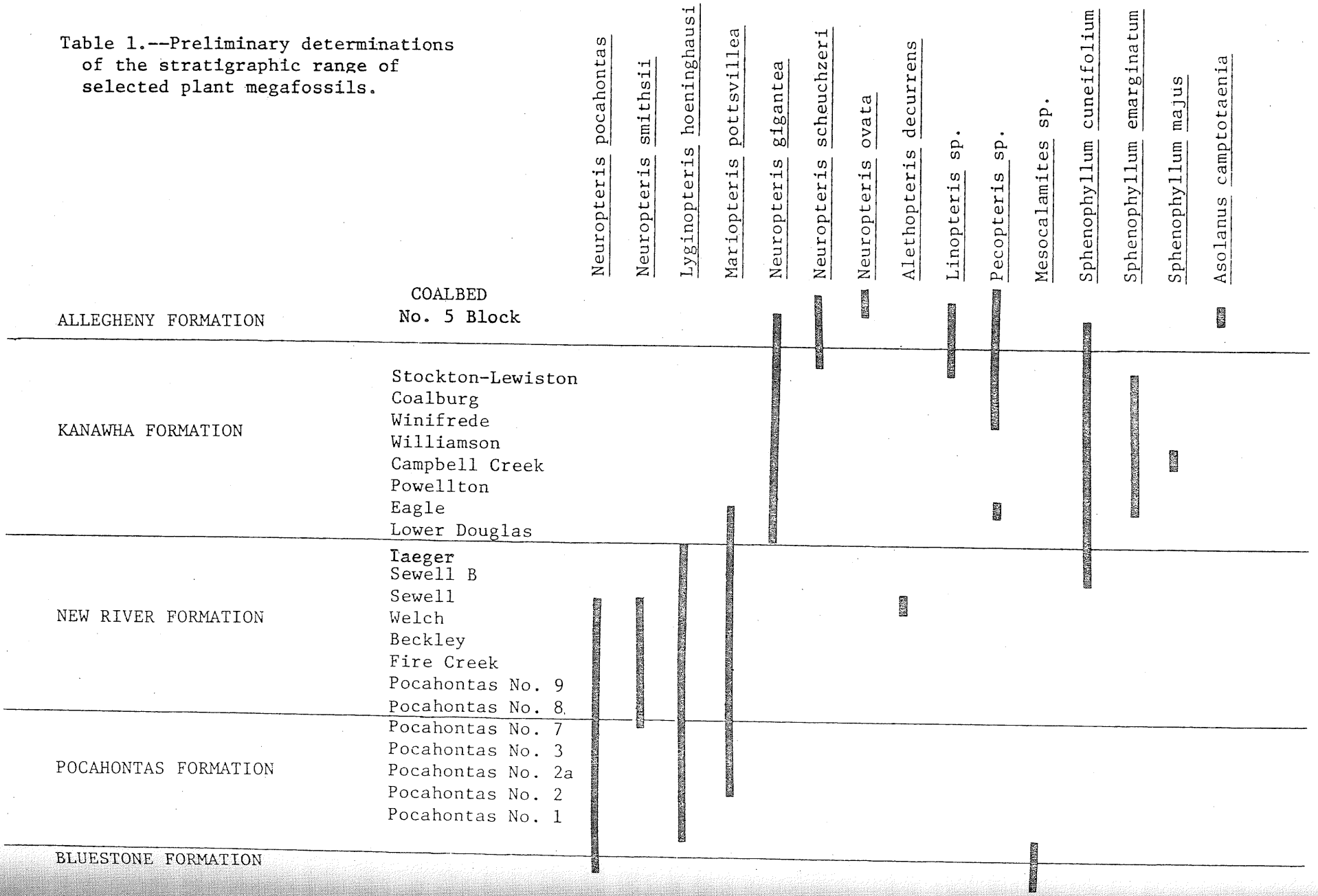
One of the earliest documentations on paleontology in North America was published in 1836 by Samuel P. Hildreth and S. G. Morton, two medical doctors from Marietta, Ohio, who had walked through and studied the natural history of Ohio, West Virginia and Pennsylvania. In the middle 1850s, Leo Lesquereux, widely acknowledged as the "Father of American Paleobotany", described some of the fossils collected by these early naturalists as being new to science, and published new names for them. Lesquereux later expanded his studies to include fossil plants from throughout the coal-bearing rocks of the United States, and published the results in three volumes. This world-famous triology, issued in 1879, 1880 and 1884 by the Second Geological Survey of Pennsylvania, although long outdated, is still the only comprehensive work published in America on plant fossils found in rocks associated with Carboniferous-age coals. A second very important work, dealing with the fossil plants contained in the uppermost (youngest) rocks of the Appalachians, was issued by the Pennsylvania Geological Survey in 1880. It was authored by William Fontaine and I. C. White.

The next serious student of paleontology was David White, who became an authority on the fossils of the Mississippian and lower Pennsylvanian strata.

The expansion of surface-mining and highway construction has greatly increased the collection and knowledge of paleontology in West Virginia in recent decades.

The strata exposed in the New River Gorge contain numerous fossils. A few limestone outcrops contain a variety of marine fossils. There are quite a few strata; especially of the coals and shales, which contain numerous plant fossils. The following figure shows the stratigraphic ranges for several of the key plant fossils which are known to occur in the New River area.

Table 1.--Preliminary determinations of the stratigraphic range of selected plant megafossils.



At the time of the Mississippian Period, the invertebrates, crinoids, and blastoids reached their climax. Lacy bryozoa and spiny brachiopods expanded. Foraminifera became important for the first time. Gastropods and pelecypods were also important. Corals became less important, and trilobites were approaching extinction.

Among the vertebrates, fish were less important than in the Devonian but were still abundant. Among the Mississippian fish were sharks who fed on crustaceans and were equipped with teeth that could crush the shells of their prey. The principal land animals were amphibians whose footprints have been found in the terrestrial deposits, but remains of these are scarce.

The Hinton Formation consists of argillaceous limestone and calcareous shale containing abundant marine fossils including brachiopods, pelecypods, gastropods and bryozoans. Marine fossils including brachiopods, pelecypods, gastropods and cephalopods occur locally in the Bluestone Formation. The Bramwell Member of the Mississippian has a basal bed of black carbonaceous shale containing abundant ostracodes and pelecypods. The overlying beds of the Bramwell contain brachiopods and pelecypods.

Most characteristic of the life of the Pennsylvanian are the fast-growing, soft-tissued trees and other plants that formed the vast swamp forests of this period. Perhaps nowhere else on the continent were these more important than in West Virginia, for it was from these that almost all of the commercial coal deposits of the State were formed. Although seed-bearing plants were present, the spore-bearing plants were more abundant. Ferns, horsetails, rushes, and the like, which we know only as relatively small plants, commonly grew to large size. Conifers were still very primitive, and flowering plants had not yet come into existence.

Primitive insects, including many of the largest known, were abundant. Also important were the centipedes, spiders, scorpions, and small land snails. Fishes continued to be important. Various clumsy amphibians and even a few small reptiles roamed the swamps and land areas.

Invertebrate marine life continued in abundance. Most important were the brachiopods, lacy bryozoa, pelecypods, and

gastropods. Foraminifera, mostly of very small size, were also abundant and are important in correlation of Pennsylvanian rocks outside of West Virginia. Corals and echinoderms were also present. Blastoids made their last stand.

The Pocahontas Formation of the Pennsylvanian contains numerous plant fossils, including stems, leaves, and roots throughout the Formation. The New River Formation also has plant fossils in most of the various beds. Fossil plants, including leaves, roots and stems are common in many of the Kanawha Formation beds.

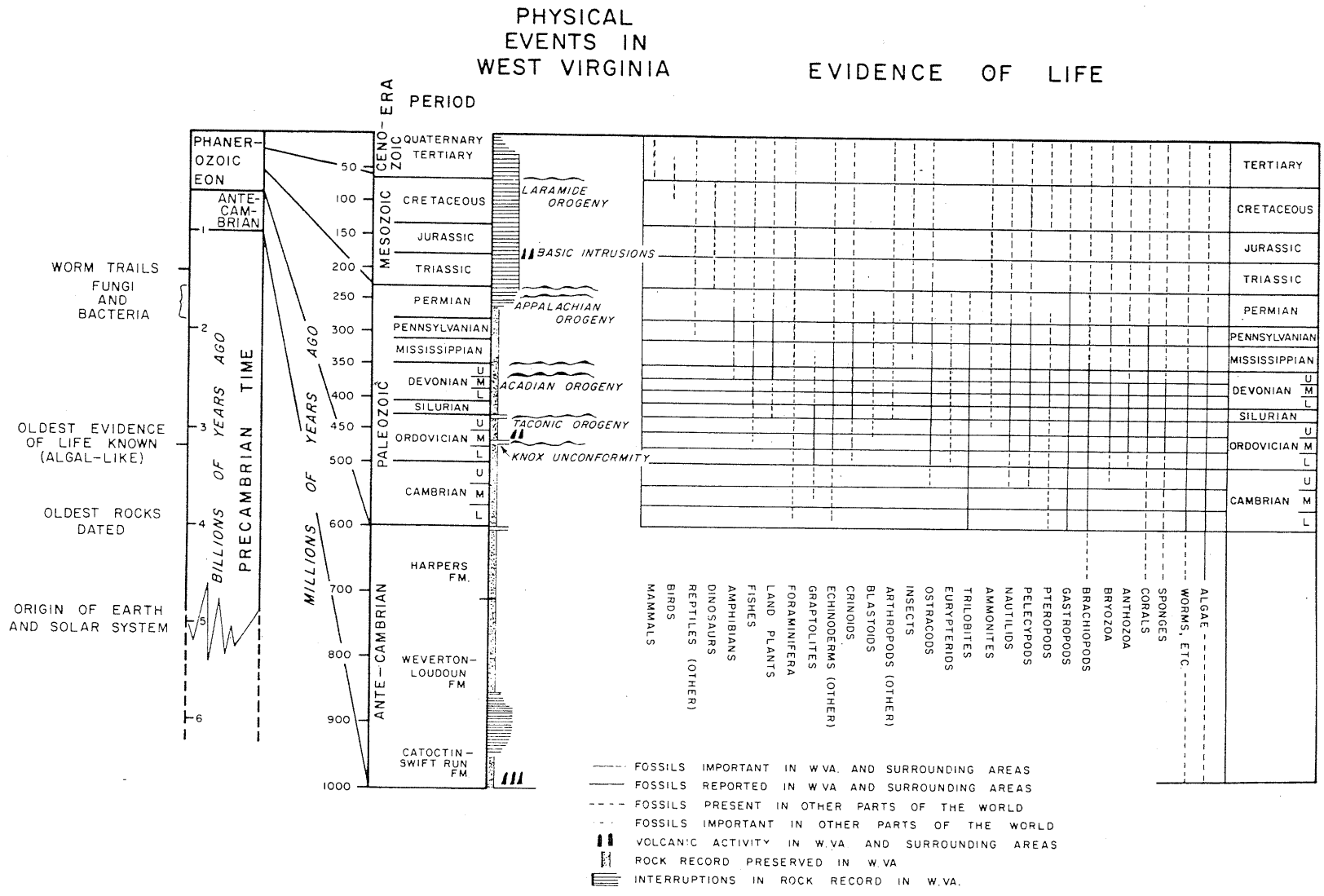
The following geologic time chart and stratigraphic column indicates the appearance and times of prominence of certain marine and plant fossils:

Era	Period	Epoch	Dominant life: Plants	Dominant life: Animals	Began millions of years ago
Cenozoic	Quaternary	Recent	Herbaceous plants rise. Forests and grasses spread	Man appears	
		Pleistocene			2.5
	Tertiary	Pliocene		Modern mammals appear and develop	13
		Miocene			26
		Oligocene			38
		Eocene			58
		Paleocene			65
Mesozoic	Cretaceous		Angiosperms appear, Gymnosperms decline	Dinosaurs reach peak, first snakes appear	135
	Jurassic		Cycads prevalent	First birds	190
	Triassic		Gymnosperms rise, Seed Ferns die out	Mammals appear, reptiles prominent	230
Paleozoic	Permian		Conifers & Cycads important	Reptiles dominant, first beetles	280
	Carboniferous	Pennsylvanian	Lepidodendron, Sigillaria and Calamites dominant	Age of Cockroaches First reptiles	325
	Carboniferous	Mississippian	Lycopods & Seed Ferns abundant	Peak of Crinoids and Bryozoans	355
	Devonian		First spread of forests	First amphibians, insects & spiders	410
	Silurian		First known land plants	First air breathers	435
	Ordovician		Algae, Fungi Bacteria	Peak of Trilobites, first fishes	500
	Cambrian		Algae, Fungi Bacteria	Trilobites and Brachiopods	570
Precambrian			Algae, Fungi Bacteria		(Oldest rocks) 3700
					4700

Geologic time chart

ERA	SYSTEM	GROUPS AND FORMATIONS		IMPORTANT COAL BEDS
PALEOZOIC (UPPER)	TRANSITIONAL PERMIAN-PENNSYLVANIAN?	DUNKARD GROUP	GREENE FORMATION	NONE PRESENTLY OF VALUE
			WASHINGTON FORMATION	WASHINGTON◂
		MONONGAHELA GROUP		WAYNESBURG◂ SEWICKLEY REDSTONE PITTSBURGH◂
		CONEMAUGH GROUP		ELK LICK BAKERSTOWN• MAHONING
		ALLEGHENY GROUP		UPPER FREEPORT◂ LOWER FREEPORT UPPER KITTANNING◂ MIDDLE KITTANNING• NO. 5 BLOCK◂ CLARION
	PENNSYLVANIAN	POTTSVILLE GROUP	KANAWHA FORMATION	UPPER MERCER STOCKTON◂ COALBURG BUFFALO CREEK WINIFREDE CHILTON THACKER HERNSHAW WILLIAMSON CEDAR GROVE◂ LOWER CEDAR GROVE ALMA PEERLESS, NO 2 GAS } CAMPBELL CREEK◂ POWELLTON EAGLE LITTLE EAGLE LOWER WAR EAGLE GILBERT DOUGLAS
			NEW RIVER FORMATION	IAEGER SEWELL "B" SEWELL◂ WELCH LITTLE RALEIGH BECKLEY• FIRE CREEK NO. 9 POCAHONTAS
			POCAHONTAS FORMATION	NO. 7 POCAHONTAS NO. 6 POCAHONTAS NO. 5 POCAHONTAS NO 4 POCAHONTAS• NO. 3 POCAHONTAS• NO. 2 POCAHONTAS

Figure Geologic position of important West Virginia coal seams. A few good plant-fossil-collecting horizons are indicated.



Geologic Time Scale Showing Major Events in the Geologic History of W. Va.

Pocahontas Group depositions reveal no marine life in the State, but non-marine pelecypoda, crustacea and vermes occasionally thrived in the basins. In the upper portion of the New River Group, after 1040 feet had been deposited there was a connection between the ocean and the basin in which sedimentation was in progress and a single marine species, Lingula kanawhensis, found its way past the barriers which had existed. After its withdrawal 260 feet of New River sediments were laid down. Almost at the beginning of Kanawha time another incursion of marine waters took place and a restricted, but truly marine fauna appeared, consisting of the same species of Lingula, four pelecypoda, one scaphopod and at least four species of gastropoda. This was the herald of a profuse fauna which shortly appeared in the Eagle limestone. A few of the species of the older fauna returned with many others, 35 in all, about evenly distributed between the brachiopoda and pelecypoda, with two gastropoda. Following this 700 feet of strata intervened before marine faunas again had full access to the region. During this time there were several periods of partial or restricted communications with oceanic waters when a few species appeared. The close of this period marks the last appearance of a number of the former inhabitants of the region, particularly among the pelecypoda. Several of the latter are here described for the first time. Finally, beginning with the deposition of the Seth Limestone, a period of frequent invasion of oceanic waters was inaugurated, bringing the fairly rich faunas of the Dingess, Winnifrede and Buffalo Creek Limestones, terminated, in many places, but not,so far as known, within the area of Raleigh, Wyoming and McDowell Counties, by the appearance and subsequent withdrawal of the Kanawha Black Flint fauna. (Krebs 1916).

From the table showing the stratigraphic distribution of the Pottsville fossils of the State the following species are seen to be restricted to the Series so far as now known:

Clinonolithes canna
Enchostoma elkensis
Enchostoma sp.
Lingula kanawhensis
Lingula lemniscata
Spirifer boonensis
Orbiculoidea capuliformis
Crania modesta
Schizophoria altirostris
Schizophoria resupinoides
Prothyris carinata
Schizodus coneatus
Deltopecten eaglensis
Deltopecten flabellum
Deltopecten sp.
Allerisma guyandotensis
Astartella gurleyi
Minute pelecypods (2 sp.)
Pleurotomaria carbonaria
Strophostylus nanus

Productus nodosus	Aclisina conditi
Spiriferina kentuckyensis	Aclisina sp.
Hustedia multicostata	Conularia crustula
Sanguinolites raleighensis	Griffithides scitulus

W. Armstrong Price further listed fully the "Invertebrate Fossils from the Pottsville Section of West Virginia" on pages 678-679 or 281-285 of the detailed county reports from Raleigh and Fayette Counties, respectively.

Two fossil flora studies provide the earlier and recent sources of important information on paleobotany. The earlier was, "The Fossil Flora of West Virginia" by David White published by the WV Geological Survey in 1913. The more recent was, "Plant Fossils of West Virginia" by William H. Gillespie, et. al. published by the WV Geological and Economic Survey in 1978. A typical listing by White is as follows:

> Mariopteris muricata (Schlotheim) Zeiller. Expl. Carte Geol. France, Paris, vol. 4, Atlas, 1878, Pl. clxvii, fig. 5; text 1879, p. 71. D. White, Bull. Geol. Soc. Am., vol. 11, 1900, p. 161. (Pottsville group; Kanawha formation, and Nuttall Sandstone lentil of Sewell formation.)

The same listing by Gillespie is as follows:

> Mariopteris muricata (Plate 50-2) has elongated leaflets, 4-5 times as long as wide, with the margins tending to be lobed. This species occurs in the upper Lower Middle Pennsylvanian strata.

This paleontology summary utilized the following references as the primary sources of information:

1. Cardwell, Dudley H. 1975. Geologic History of West Virginia.
2. Gillespie, William H. et. al. 1978. Plant Fossils of West Virginia.
3. Gillespie, William H. and Hermann W. Pfefferkorn. 1976. Plant Fossils in Early & Middle Parts of the Proposed Pennsylvanian System Stratotype in West Virginia.
4. Krebs, Charles E. and D. D. Teets, Jr. 1916. Raleigh County and Western Portions of Mercer and Summers Counties - Detailed County Reports.
5. Millspaugh, C. F. and David White. 1913. Part I. The Living Flora of West Virginia---Part II. The Fossil Flora of West Virginia.

BOTANICAL EXPLORATION

The New River Gorge has proven to be a popular and productive botanical area. Numerous professional and amateur botanists have collected plants in the Gorge since the mid 1800's.

Isaac Farewell Holton collected from Gauley Bridge to Hawks Nest in October, 1849. His private herbarium was deposited in the New York Botanical Garden.

Joseph Francis James investigated the flora of Hawks Nest as part of a two-week's visit in 1877. The region of Loup Creek, Fayette County, was investigated during the same period. His plants were deposited in Harvard University Herbarium.

Dr. Charles Frederick Millspaugh, former Curator of Botany, Field Museum of Natural History, Chicago, and Botanist of the Agricultural Experiment Station of West Virginia University, visited the New River Valley as well as several localities in nearly every county of West Virginia. His field work covered two seasons. His specimens were deposited in the herbaria of West Virginia University, New York Botanical Gardens, and the Field Museum of Natural History, Chicago. His West Virginia collections were made in 1890 and 1891.

Lawrence William Nuttall, a mine operator and a pioneer amateur botanist of Nuttallburg, Fayette County, made botanical explorations and studies in the vicinity of his neighborhood.

Many of his specimens were sent to Dr. Millspaugh for identification. Dr. Millspaugh freely used the lists of Mr. Nuttall and collaborated with him. The association with Dr. Millspaugh inspired him to do more collecting. From 1890 to 1897, Mr. Nuttall collected about 1000 species of flowering plants.

After Dr. Millspaugh was made curator of Botany at the Field Museum of Natural History in Chicago, his correspondence with Mr. Nuttall continued. In 1896, they published

jointly, the Flora of West Virginia (Boone, 1965).

In 1927 Mr. Nuttall donated his valuable plant collection to West Virginia University Herbarium. The collection included thousands of specimens of seed plants and ferns as well as about 1,400 species of fungi.

Charles Louis Pollard and William Ralph Maxon collected near Quinnimont, Fayette County during the latter part of August, 1899. Their plants were deposited in the United States National Herbarium, Washington, D.C.

Edward Lyman Morris, Curator, Brooklyn Institute Museum, made a collection of plants in the region south of New River in Summers, Mercer, and Raleigh Counties in 1900. His collections were made in July and August of a dry season and is deposited in the National Herbarium, Washington, D.C. Charles L. Boynton, formerly of the Biltmore Herbarium, collected at Gauley Bridge: Thurmond, and Hinton during the month of June, 1903.

William Webster Eggleston collected at Gauley Bridge, near Thurmond, and Hinton in 1909. His collection was deposited in the New York Botanical Garden.

Maurice Graham Brooks made numerous collecting trips in the New River gorge since 1925. In 1934, his article, "Spring Comes to the New River Gorge," was published in the West Virginia Review. Many of his plant specimens are filed in the West Virginia University Herbarium. His specimens were also filed at the Smithsonian Institute and Michigan State University. (Boone).

Perry Daniel Strausbaugh, former head of the Department of Botany at West Virginia University, established the Botanical Expeditions in 1926. The "Botanical Expedition" was a class of students who traveled over the state by automobile and lived in tents for several weeks during the summer. The expedition crisscrossed the state in all directions, including the New River Valley, while making their plant collections. Earl Lemley Core, a former student of Dr. Strausbaugh, assisted him with the expedition and later, the two botanists assembled a mass of data which was published in an extensive, illustrated "Flora of West Virginia", in four volumes. (Strausbaugh and

Core: 1952, 1953,1958, and 1964).

Ellis Meade McNeill has extensively investigated the flora of southern West Virginia, including the New River Valley. He has been one of the leading contributors to the West Virginia University Herbarium since 1929.

Weldon Boone made a survey of the flora of Summers County, beginning in 1933. He has made many collections in Summers County, and surrounding counties. Most of his collections are in the West Virginia University Herbarium, (Boone, 1965).

Russel Guy Brown made a study of the flora of Fayette County from 1934 to 1936.

John Paul Tosh made a survey of the vascular plants of Raleigh County which served as a basis for his thesis for his degree of Master of Science at the University of Kyntucky in 1941 (Tosh, 1942).

Several State records were collected by Floyd Bartley, an Ohio Botanist, who explored the area from Gauley Bridge to Hawks Nest in the mid 1950's.

Violet J. S. Phillips conducted the most systematic botanical research project on New River from 1965-1968. Her studies were conducted along New River from Glen Lyn, Virginia to Gauley Bridge, West Virginia and resulted in the completion of her doctoral degree from West Virginia University.

Grafton and McGraw conducted two studies of the flora of the Gorge during the period from 1967 through 1975. These studies resulted in the publication, "The Vascular Flora of New River Gorge, West Virginia" in 1967. This flora list compiled 1067 species (10 were new State records) from 478 genera in 123 different families.

References used as the primary sources for the botanical exploration summary are as follows:

1. Core, Earl L. 1966. Vegetation of West Virginia.
2. McGraw, Claude and William N. Grafton. 1973. The Vascular Flora of New River Gorge - Manns Creek - Fayette County, West Virginia.
3. Phillips, Violet Josephine Siemicozko. 1969. The Botany of the New River Valley between Glen Lyn, Virginia and Gauley Bridge, West Virginia.

ECOLOGY OF FORESTS, COVER TYPES, AND HERBACEOUS PLANTS

The most complete description on the original forests of the area is found in A.B. Brooks, Forestry and Wood Industries published by the West Virginia Geological Survey in 1911. A lengthy quote taken from his writings is given as follows:

"The topography of Fayette is such as to promote the growth of valuable forests. Originally the low and fertile lands of the Gauley and of the portion of the Great Kanawha within the county, were characterized by the abundance of yellow poplar, black and white walnut, white and red oaks, sweet buckeye, basswood, cucumber and white ash, as well as the less valuable sweet gum, sycamore, river birch, honey locust and others. On the clays of the higher areas such species as maples, white oak, and beech predominated, with fringes of hemlock along the water courses and with scattered clumps of pitch pine and scrub pine growing on dry ridges and along the sandstone outcrops.

Large requisitions have been made upon the timber by the 150 or more, coal companies operating within the county. The quantity of timber used in mining, through a long series of years, for posts, caps, headers, ties, tipples and buildings, is enormous. In the judgement of those men best aquainted with the present situation the time is near when the scarcity of both timber and water will become alarming if, indeed, it is not already so. A number of coal companies, however, are taking steps to preserve the remnant of less valuable but rapid-growing timber still standing in the extensive cut-over forests. An enterprising company owning property on Loup Creek has built an immense dam near the head of that stream and is catching the run-off water of early freshets for their use in mining operations.

The present lumber industry embraces the operations of 2 large band mills located within the county, together with the smaller operations of about 25 portable mills. These have a combined capacity of not less than 250,000 feet per

day. The large mills are engaged in the removal of timber from the remaining virgin tracts and the small mills are cutting wherever a few thousand feet of timber can be brought together."

"There is, perhaps, 10 per cent of cleared land in the county. The remaining 446,000 acres are in forest. Only about 53,000 acres, however, are yet in virgin growth. The balance is cut-over and woodlot forest owned by coal and lumber companies and by farmers. It is estimated that there is an average stand of about 2,500 feet per acre of the less valuable kinds of timber, such as black gum, beech, sugar maple, birch, etc. yet remaining on the cut-over and woodlot land, but that at least 80 per cent of the value of the original forest has been removed. Areas aggregating 200,000 acres, or more, of cut-over lands lie chiefly in the southern and western parts of the county and are largely owned by coal companies. The principal virgin forest areas lie in the region of Big Sewell mountain, in the eastern part of the county, and, farther north, along the Meadow river."

Numerous vegetation types were found in the area of the New River. Aquatic plants were collected from the New River and its tributaries. Forest types include hydric, mesic and zeric. Hydric forests range from flood plain types such as river birch-sycamore to willow-alder swamps. Many streams are lined with a hemlock overstory with rhododendron thickets in the understory. Mesic forests occur on well-drained slopes of deep soils and include numerous mixtures of various hardwoods. Mesic forests also include the cove hardwood type. Zeric forests are primarily composed of oak-hickory associations. Special habitats in the forests are heath associations on steep rocky slopes and escarpments.

Common forest cover types defined as xeric are described in the following paragraphs.

Scarlet oak and black oak occupy dry ridges and south or west facing slopes and flats, usually below 3,000 feet. This is widespread as a cover type on the plateaus above New River Gorge. Scarlet Oak is usually the most abundant

species, and small pure stands of both species are found. Associates are chestnut oak (Q. prinus), white oak, hickories, pitch pine (Pinus rigida), black gum, black locust (Robinia pseudo-acacia), sourwood, and flowering dogwood (Cornus florida).

Chestnut oak occurs in pure stands or is predominant on rocky outcrops with thin soil. Common associates are scarlet oak, white oak, black oak, post oak, pitch pine, black gum, and red maple.

Scrub Pine is widely distributed along the cliffs of New River. It is a temporary type of community, often originating in old fields. Principal associates are shortleaf pine, chestnut oak, white oak, red oak, black oak, red m aple, and black gum.

Black locust is found mainly on dry, limestone outcrops, abandoned fields, and roadsides. It occurs frequently.

White pine - chestnut oak communities occupy mountain slopes, and flat ridgetops. They occur both on sandy or gravelly dry sites. They are associated with scarlet oak, red maple, pitch pine, shortleaf pine, and black gum; common at 1,500 feet elevations and above.

The understory includes small trees and shrubs. Among these are hop hornbeam (Ostrya virginiana), flowering dogwood, downy serviceberry (Amelanchier arborea), red bud (Cercis canadensis), and witchhazel (Hamamelis virginiana). Other understory trees and shrubs include: black haw (Viburnum prunifolium), black birch (Betula lenta), dwarf hackberry, (Celtis pumila), New Jersey Tea Ceanothus americanus), and late low blueberry (Vaccinium vacillans). American chestnut (Castanea dentata) was formerly abundant, but exists today only as persisting root sprouts.

Ericaceous shrubs are abundant: among these are great laurel (Rhododendron maximum), pink rosebay (R. catawbiense), mountain laurel (Kalmia latifolia), pink azalea (Rhododendron nudiflorum), flame azalea (Rhododendron calendulaceum), deerberry (Vaccinium stamineum), trailing arbutus (Epigaea repens), teaberry Gaultheria procumbens), round leaved American winter-

green (Pyrola rotundifolia), and spotted wintergreen (Chimaphila maculata).

Some vining shrubs include; climbing bittersweet (Celastrus scandens), summer grape (Vitis aestivalis), Virginia creeper (Parthenocissus quinquefolia), poison-ivy (Rhus radicans), and greenbrier (Smilax sp.).

The ground layer on the xeric area has relatively few spring bloomers and more summer bloomers compared to the mesic forest.

Common forest herbs of spring and early summer include: common woodrush (Luzula multiflora), Yellow stargrass (Hypoxis hirsuta), early meadowrue (Thalictrum dioicum), cinquefoil (Potentilla simplex), pink ladies' slipper (Cyperidium acaule), Solomon's seal (Polygonatum biflorum), wild geranium (Geranium maculatum), Lousewort (Pedicularis canadensis), forked chickweed (Paronychia canadensis), fire pink (Silene virginica), rattlesnake hawkweed (Hieracium venosum), sanicle (Sanicula spp.), violets (Viola spp.), blazing star (Chamaelirium luteum), partridgeberry (Mitchella repens).

Herbs of late summer and autumn in the xeric forests are as follows: enchanter's nightshade (Circaea quadrisulcata), panic grass (Panicum microcarpon), rattlesnake plantain (Goodyera pubescens), wild indigo (Baptisia tinctoria), galax (Galax aphylla), bush-clover (Lespedeza spp.), sticktights (Desmodium spp.), white avens (Geum canadense), whorled loosestrife (Lysimachia quadrifolia), southern mountain-mint (Pycnanthemum pycnanthemoides), dittany (Cunila origanoides), agrimony (Agrimonia spp.), asters (Aster spp.), goldenrods (Solidago spp.), white leafcup (Polymnia canadensis), sunflowers (Helianthus spp.), wild lettuce (Lactuca spp.), lion's foot (Prenanthes spp.), and squawweed (Senecio obovatus).

Parasitic herbs of autumn are the Indian pipe (Monotropa uniflora), beechdrops (Epifagus virginiana), and cancerroot (Conopholis americana).

The mesic portion of the mixed hardwood forest is found on moist habitats of north facing slopes and in coves. Dominance is shared by a large number of species. The composition

and relative abundance of the dominants vary greatly from place to place.

The most common cover type is designated as the cove hardwood type. It occurs on north and east facing slopes and deep ravines with deep, rich, well-drained soils. The composition is a complex mixture of the following trees: yellow poplar, cucumbertree, basswood, red oak, white oak, beech, yellow buckeye, sugar maple, black walnut, white ash, and shagbark hickory.

White oak occurs on well-drained, loamy soils. It is one of the most widely distributed timber trees of West Virginia. It is found in almost every wooded locality.

White oak - black oak - red oak communities are common on loamy well-drained soils at elevations from 500 to 2,000 feet. Associates include American elm (Ulmus americana), red maple, black walnut (Juglans nigra), basswood (Tilia heterophylla), black locust, beech (Fagus grandifolia), and black gum.

Red oak occurs on northern exposures in pure or predominating stands. Associates are black oak, scarlet oak, chestnut oak, and tulip tree.

Tulip tree is found in moist coves and flats, and abandoned fields. Occasional associates are red maple, black locust, black birch (Betula lenta), red oak, and cucumber tree (Magnolia acuminata).

Tulip tree and hemlock are occasionally dominant species along streams at the bottom of slopes.

Occasional pure stands of beech occur along stream banks.

Other trees which seldom reach canopy-layer height are found in the mesic forest. These include: mountain magnolia (Magnolia fraseri), sourwood (Oxydendrum arboreum), striped maple (Acer pensylvanicum), red bud, blue beech (Carpinus caroliniana), holly (Ilex opaca), downy serviceberry, and flowering dogwood.

Among the smaller trees and shrubs are spicebush (Lindera benzoin), witch hazel, pawpaw (Asimina triloba), hydrangea (Hydrangea arborescens), dockmackie (Viburnum acerifolium), and prickly gooseberry (Ribes cynosbati), black elderberry (Sambucus canadensis), strawberry bush (Euonymous americanus),

wahoo (E. atropurpureus), and Hercules' club (Aralia spinosa).

Woody lianas include Virginia creeper, various species of wild grape, bittersweet and moonseed (Menispermum canadense).

In early spring before leaves appear on deciduous trees the forest floor is covered with many species of herbaceous flowers. Among them are various species of trillium (Trillium spp.), yellow fawn lily (Erythronium americanum), yellow lady's slipper (Cypripedium pubescens), many violets, bloodroot (Sanguinaria canadensis), dwarf larkspur (Delphinium tricorne), wild blue phlox (Phlox divaricata), spring beauty (Claytonia spp.) rue anemone (Anemonella thalictroides), papoose-root (Caulophyllum thalictroides), squirrel-corn (Dicentra canadensis), Dutchman's breeches (D. cucullaria), foam flower (Tiarella cordifolia), Jack-in-the-Pulpit, (Arisaema triphyllum), bellworts (Uvularia spp.), white clintonia (Clintonia umbellulata), plumelily (Smilacina racemosa), hairy disporum (Disporum lanuginosum), carrionflower (Smilax herbacea), dwarf crested iris (Iris cristata), ginger (Asarum canadense), hepaticas (Hepatica spp.), goldenseal (hydrastis canadensis), ginseng (Panax quinquefolius), mayapple (Podophyllum peltatum), toothworts (Dentaria spp.), sweet anise (Osmorhiza spp.), Greek valerian (Polemonium reptans), Virginia waterleaf (Hydrophyllum virginianum), small-flowered phacelia (Phacelia dubia), fern-leaved phacelia (Phacelia bipinnatifida).

The silvery spleenwort (Athyrium thelypterioides) and brittle fern (Cystopteris fragilis), occur frequently in Mesic forests in spring. Throughout the year the Christmas fern (Polystichum acrostichoides) is conspicuous on steep slopes and the common polypody (Polypodium virginianum), cannot be overlooked on moist boulders and cliffs.

In the summer, under the heavy foilage of the forest canopy, few plants are found with showy flowers. Among summer blooming species is: wood nettle (Laportea canadensis), puttyroot (Aplectrum hymale), black snakeroot (Cimcifuga racemosa), Aconite saxifrage (Boykinia acontifolia), showy skullcap (Scutellaria serrata), leatherflower (Clematis viorna). Some of the ferns found here are the shield-fern (Dryopteris mar-

ginalis), broad beech fern (Phegopteris hexagonoptera), and maiden-hair fern (Adiantum pedatum).

Late summer and autumn plants include: cranefly orchid (Tipularia discolor), starry campion (Silene stellata), touch-me-nots (Impatiens spp.), richweed (Collinsonia canadensis), American bellflower (Campanula americana), white snakeroot (Eupatorium rugosum), goldenrods (Solidago spp.), asters (Aster spp.), yellow leafcup (Polymnia uvedalia).

The hydric portion of the mixed hardwood forest is developed on flood plains along the larger streams, and is not subject to long periods of overflow.

Bottomlands are frequently enriched by the deposition of silt during spring flooding. Vegetation along New River fits this category mostly, although the hydric communities are mostly not very extensive because of the narrowness of the valley and steep river gradient.

The bottomlands and floodplain forests of New River are included here as the hydric types despite the fact they most often occur on moist, well drained soils.

Among the trees, black willow (Salix nigra), sycamore (Platanus occidentalis), sweet gum (Liquidambar styraciflua), silver maple (Acer saccharinum), and river birch (Betula nigra), are often very abundant.

Other species common to the area are red maple, box elder (Acer negundo), American elm, red ash (Fraxinus pennsylvanica), cottonwood (Populus deltoides), honey locust (Gleditsia triacanthos), hackberry (Celtis occidentalis), and the introduced imperial tree (Paulownia tomentosa).

River birch-sycamore communities are often found in moist soil along creek and river banks. Associates are red maple, black willow, silver maple, box elder and Kentucky coffeetree (Gymnocladus dioica).

Silver maple-American elm communities are common on silty soil of river bottoms and flood plains. Associates include red maple, cottonwood, and, red ash and cottonwood.

Chief associates are sandbar willow (Salix interior), Ward's willow (Salix caroliniana), fringetree (Chionanthus

virginicus), persimmon (Diospyros virginiana).

Invaders are sycamore, river birch, white ash (Fraxinus americana), red ash, American elm, slippery elm (Ulmus rubra), silver maple, red maple and red gum.

Sand grape (Vitis rupestris), frequently invades the rocky sands at the river edges.

In rich alluvial soil along banks of streams are many kinds of shrubs such as willows (Salix spp.), alder (Alnus serrulata), ninebark (Physocarpus opulifolius), winterberry (Ilex verticillata), bladdernut (Staphylea trifolia), strawberry bush (Euonymus americanus), kinnikinnik (Cornus ammomum), and buttonbush (Cephalanthus occidentalis). Other shrubs of this area are pawpaw (Asimina triloba), leatherbark (Dirca palustris), hoptree (Ptelea trifoliata) and toothache tree (Zanthoxylum americanum). Virgin's Bower is the most common vine along stream banks.

Many species grow among the shrubs and along the margin of streams. Among these are climbing plants such as greenbrier (Smilax rotundifolia), climbing false buckwheat (Polygonum scandens), poison ivy, bindweed (Convolvulus sepium), morning-glory (Ipomoea purpurea), bur-cucumber (Sicyos angulatus), riverbank grape (Vitis riparia), Virginia creeper, moonseed (Menispermum canadensis), wild yam (Dioscorea villosa), virgin's bower, cinnamon vine (Dioscorea batatas), and bittersweet.

Among the herbs are many grasses such as rice cutgrass (Leersia oryzoides), manna-grass Glyceria striata), wood reed grass (Cinna arundinacea) wild ryes (Elymus spp.), deer-tongue grass (Panicum clandestinum), switch grass (Panicum virgatum), bromegrasses (Bromus spp.) and bottle-brush grass (Hystrix patula).

Numerous mints grow along riverbanks such as peppermint (Mentha piperita), spearmint (Mentha spicata), water horehound (Lycopus virginicus and L. americanus), germander (Teucrium canadense), giant hyssop (Agastache nepetoides), hedge nettle (Stachys tenuifolia) and dragonhead (Dracocephalum virginianum).

Included in the herbaceous plants along streams are many composites such as Joe Pye weed (Eupatorium fistulosum), sunflower (Helianthus spp.), goldenglow (Rudbeckia laciniata), and swamp beggarticks (Bidens spp.), Jerusalem artichoke (Helianthus tuberosus) and rough aster (Aster patens).

Other herbaceous species include false nettle (Boehmeria cylindrica), swamp milkweed (Asclepias incarnata), turtlehead (Chelone glabra), monkey flower (Mimulus ringens), cardinal flower (Lobelia cardinalis), wild onion (Allium cernuum), yellow iris (Iris pseudoacorus), blue indigo (Baptisia australis), great blue lobelia (Lobelia siphilitica), showy goldenrod (Solidago speciosa), early goldenrod (Solidago juncea), cup-plants (Silphium connatum & trifoliatum) and great Indian plantain (Cacalia muhlenbergii). This is a favorable habitat for dodder (Cuscuta gronovii) and scouring rush (Equisetum hyemale).

Pioneer stages develop on wet, newly deposited banks of sand or mud. These may be invaded by sedges (Carex, Scirpus, Cyperus and Eleocharis spp.) cattails (Typha latifolia), arrowhead (Sagittaria latifolia), water plantain (Alisma subcordatum) and bur-reeds (Sparganium americanum). Along New River, lizard's tail (Saururus cernuus) is abundant in some areas. Rare plants such as creeping dayflower (Commelina diffusa), lovegrass (Eragrostis wiegeltiana) and golden loosestrife (Lysimachia vulgaris) have been found as pioneer succession species.

Barren rocks also provide pioneer succession areas. Dry exposed sandstone cliffs are most frequently vegetated with scrub pine, pitch pine, rhododendrons, mountain laurel and blueberries. The herbaceous plants will consist of poverty grasses (Danthonia spp.) panic grasses (Panicum spp.), little bluestem (Andropogon scoparius), pussytoes (Antennaria spp.) and various ferns such as the hairy lip fern (Cheilanthes lanosa).

Several species of rock cress (Arabis spp.) and alumroots (Heuchera spp.) occur in rocky places.

Rock crevices and recesses provide a suitable habitat for such plants as wood fern (Woodsia obtusa), ebony spleenwort (Asplenium platyneuron), wild columbine (Aquilegia canadensis), stone crop (Sedum ternatum), early saxifrage (Saxifraga virginiensis), wild liveforever (Sedum telephioides) and walking fern (Camptosorus rhizophyllus). Along rocky riverbanks are found

species such as riverbank goldenrod (Solidago racemosa), big bluestem (Andropogon gerardi), McDowell's sunflower (Helianthus dowellianus), eastern gama grass (Tripsacum dactyloides), tasselrue (Trautvettaria caroliniensis) and shrubby yellow root (Xanthoriza simplicissima).

Several major rock strata outcrops at riverbed level have unusual plant communities. Prominent outcrops occur at Sandstone Falls, McKendree, mouth of Keeneys Creek, Hawk's Nest Dam, Cotton Hill and Gauley Junction. Plants of these outcrops are rock spikemoss (Selaginella rupestris), dwarf dandelion (Krigia virginica), meadow beauty (Rhexia mariana), stiff aster (Aster linariifolius), slender gerardia (Gerardia tenuifolia) and blazing star (Liatris spicata). It is assumed the rare Torrey's Mountain-mint (Pycnanthemum torrei) was originally collected on the outcrops at the mouth of Keeneys Creek.

In the water are found such plants as pondweed (Potamogeton spp.), naiad (Najas spp.) arrowhead (Sagittaria spp.), water plantain (Alisma subcordatum), water-willow (Justicia americana), Canada waterweed and mud-plantain (Heteranthera dubia).

Many rooted herbs are found along the shore. Among these are smartweeds (Polygonum spp.), beggar-ticks (Bidens spp.), sedges (Carex spp.), and tearthumb (Polygonum sagittatum). An interesting plant living attached to boulders in the rapids of New River is riverweed (Podostemum ceratophyllum).

Evidence indicates that several plants have migrated along New River. Most of these plants are found only on the pioneer succession areas of sand and rocks of the open flood plains. Among these unusual plants are eastern gama grass, prairie cordgrass (Spartina pectinata), Florida pellitory (Parietaria floridana), bittercress (Cardamine clematitis), bittercress (Cardamine impatiens), red gum, hoptree, Virginia mallow (Sida hermaphrodita), meadow beauty (Rhexia mariana), sweet pepperbush (Clethra acuminata), rose mallow (Hibiscus moscheutos), trumpet creeper, crossvine (Bignonia capreolata), silverbell, fringetree, mistletoe (Phoradendron flavescens), showy goldenrod (Solidago speciosa), McDowell's sunflower, and Small's ragwort (Senecio smallii).

Numerous rocky ravines and talus slopes are present in New River Gorge. Those on northern exposures are quite cold and damp. Some of these ravines occur as low as 1000 feet elevation and contain plants which normally are found above 2500 feet elevation. A partial listing of these unique plants is as follows:

Fraser's sedge-Carex fraseri
Yellow birch-Betula alleghaniensis
Mountain bugbane- Cimicifuga americana
White baneberry-Acteae pachypoda
Allegheny vine-Adlumia fungosa
Aconite saxifrage-Boykinia acontifolia
White wood sorrel-Oxalis montana
Mountain maple-Acer spicatum
Mountain Holly-Ilex montana
Dwarf Ginseng-Panax trifolius
Alpine Enchanter's-Nightshade-Circaea alpina
Rock skullcap-Scutellaria saxitilis
Hobblebush-Viburnum alnifolium
Red elderberry-Sambucus pubens
Vervain thoroughwort-Eupatorium pilosum
Mountain aster-Aster acuminatus

Several unusual plants were cultivated in the boom towns of the coal mining era of the late 1800's and early 1900's. Many have persisted with some being well established. Still others are exotics, adventives and introduced weeds. Some of the more important of these are as follows:

Paspalum dilatatum
Indian Nutgrass-Sorghastrum nutans
Reed-Phragmites communis
Spiderwort- Tradescantia virginiana
Asiatic Day-flower- Commelina communis
Common Day Lily-Hemerocallis fulva
Adam's Needle- Yucca filamentosa
Garden Asparagus-Asparagus officinalis
Yellow Iris- Iris pseudoacorus

Bouncing Bet-Saponaria officinalis
Japanese Quince-Chaenomeles japonica
Multiflora Rose-Rosa multiflora
Wisteria-Wisteria frutescens
English Ivy- Hedera helix
Parsnip-Pastinaca sativa
Periwinkle-Vinca minor
Japanese Honeysuckle-Lonicera japonica
One-seeded bur-cucumber-Sicyos angulatus
Eupatorium hyssopifolium
Small's ragwort-Senecio smallii
Yellow Goats-beard-Tragopogon pratensis

References used as the primary sources for the "ecology" summary are as follows:

1. Brooks, A. B. 1911. Forestry and Wood Industries.
2. Grafton, William N. and Claude McGraw. 1976. The Vascular Flora of New River Gorge, West Virginia.
3. McGraw, Claude and William N. Grafton. 1973. The Vascular Flora of New River Gorge - Manns Creek - Fayette County, West Virginia.
4. Phillips, Violet Josephine Siemicozko. 1969. The Botany of the New River Valley between Glen Lyn, Virginia and Gauley Bridge, West Virginia.

RARE AND ENDANGERED PLANTS

There are no native plants in New River that occur on the most recent federal list of rare and endangered species as compiled by the US Fish and Wildlife Service. The rare and endangered plants of West Virginia is being revised and is scheduled for publication in early 1981. This new list is nearly finalized as the result of efforts by the WV Heritage Trust Program, WV University and Marshall University. The following plants are found in New River Gorge and will likely be on this revised list of West Virginia's rare and endangered flora:

Lygodium palmatum Climbing Fern	open and brushy swamp-Washington Carver Camp verified in Sept. 1980
Athyrium angustum Northeastern Lady Fern	moist woods near Lake Babcock 8-12-73
	moist soil below cliff & in railroad ditch above Gauley 8-18-74
Pellaea glabella Smooth Cliffbrake	rocks near Sandstone Falls on south bank of New River 7-13-68
Woodsia ilvensis Rusty Cliff Fern	along road in sandstone crevices near Sandstone Falls June 1975
Woodsia scopulina V. appalachiana Allegheny Cliff Fern	dry rocky area at the north end of 2nd trestle of Manns Creek Switchback in Babcock State Park 10-21-73
Typha angustifolia Narrow-leaved Cattail	wet ditch along Glade Creek Road 10-1-72
	wet ditch of railroad above Fayette Station 1977
Najas gracillima	aquatic at mouth of Dowdy Creek 8-29-76
Aristida lanosa Wooly Three-awn Grass	Nuttallburg Aug. 1892
	rock outcrops at mouth of Keeneys Creek 9-8-74
	rock outcrops at Sandstone Falls 10-17-74
Digitaria filiformis Finger Grass	sand along New River 9-17-56

Eragrostis hirsuta Love Grass	along side of clay road 0.5 mile below Hinton 8-25-40
Eragrostis wiegeltiana Love Grass	muddy railroad ditch below Meadow Creek 1974
Gymnopogon ambiguus Broad-leaved Beardgrass	open floodplain halfway between Cotton Hill and Hawks Nest Dam 9-14-76
Muhlenbergia capillaris Muhly Grass	edge of rock cliff at Cotton Hill bridge 9-7-77
Melica mutica Melic Grass	moist woods of flood plain at West Sewell 5-20-73
	dry woods at the mouth of Piney Creek 4-13-67
	woodlands 1.25 miles above coal mine at Terry 5-31-41
	Brooks Mountain 7-2-61
	floodplain forest halfway between Cotton Hill bridge and Hawks Nest Dam 4-27-75
Paspalum dilitatum	moist railroad ballast at Gauley 11-15-75
Phragmites communis Common Reed	wet railroad ditch below McKendree 8-27-72
Poa saltuensis Bluegrass	Stone Cliff 5-19-67
Sporobolus asper Grass	moist soil of railroad bank at West Sewell 1973
Carex alopecoidea Sedge	mouth of Wolf Creek near Fayette Station 5-22-67
Carex comosa Sedge	wet soil of railroad ditch at Ames 5-20-74
Carex emoryi Sedge	along New River 1.25 miles below bridge at Hinton 5-9-41
Carex fraseri Fraser's Sedge	Manns Creek in Babcock State Park June 1960 verified in 1980
	Nuttall Station 5-21-1892
	Other verified locations for this unusual sedge include: Minden Railroad above Thurmond (Fayette) Laurel Creek below Lawton (Fayette) Near Boone on Keeneys Creek (Fayette) Glade Creek (Raleigh)

Carex mesochorea Sedge	old Army Corps of Engineers Camp at Prince 4-31-75
Carex polymorpha Sedge	dry cleft in boulder in Wolf Creek gorge near Fayette Station 5-25-74
Carex typhina Sedge	Prince Camp 7-6-68
Carex umbellata Sedge	rock outcrops below Cotton Hill bridge 4-27-75
Cyperus refractus	Camp Brookside 8-14-58
Eleocharis compressa Spikerush	Nuttallburg 1890
Rhynchospora globularis Beakrush	rock outcrops at Cotton Hill 8-13-72
Xyris torta Yellow-eyed Grass	New River Gorge at Cotton Hill 7-6-29
Creeping Dayflower Commelina diffusa	wet sandy beach 200 yards below Hawks Nest Dam 9-14-76
	sandy beach at Sewell 1977
Commelina erecta Slender Dayflower	railroad ballast at mouth of Keeneys Creek 7-23-67
Heteranthera reniformis Mud plantain	shallow pool at Gauley Station 9-17-57
	wet muddy riverbank at Cotton Hill 9-14-76
Juncus platyphyllus Rush	south bank of river about 1 mile above bridge at Stone Cliff
Smilacina stellata Star-flowered Solomon's Seal	riverbank near Bellpoint 6-30-33
Habenaria psycodes Small Purple Fringed Orchid	Nuttallburg 5-14-1892
Pogonia ophioglossoides Beard-flower	Kates Branch swamp 7-2-75
Triphora trianthophora Nodding pogonia	Short Creek in the camp woods at 1300' elevation 8-16-1892
	sandy soil in woods by New River 0.75 mile north of Rt. 20 on road to Meadow Creek 8-8-60

Calopogon pulchellus Grass Pink	Kates Branch swamp 7-2-75
Spiranthes lucida Shining Ladies' tresses	Cotton Hill 6-9-54
Spiranthes tuberosa Little Ladies' tresses	dry railroad siding below Cotton Hill Station 8-18-74
Corallorhiza wisteriana Wister's Coralroot	moist woods at Marr Branch 10-20-78
Salix discolor Glaucous Willow	along New River at Cotton Hill 6-22-49
Salix lucida Shining Willow	railroad siding at Sewell 9-10-72
Celtis laevigata Sugarberry	McKendree to Quinnimont 1967 through 1975
Parietaria floridana Florida Pellitory	dry bank of railroad above Fayette 8-13-72
Asarum shuttleworthii Large-flowered Heartleaf	Madams Creek 5-5-32
Paronychia fastigiata Hairy Forked Chickweed	riverbank just below Contrary Creek 1895
Thalictrum clavatum Mountain Meadowrue	Nuttallburg 1898
Thalictrum steeleanum Steele's Meadowrue	rock pile on side of mountain at Terry 5-22-40
Anemone minima Dwarf Anemone	moist woods in Babcock State Park April 1967
	Nuttallburg 5-5-1892
Cardamine clematitis Bittercress	moist sandy riverbank near the west end of Stretcher's Neck Tunnell 5-8-73
	moist woods on Cotton Hill flood plain 6-4-72
	near Thurmond along New River 5-8-67
Sibara virginica Virginia Cress	bottom of hill in New River Gorge at Cotton Hill 6-8-54
Arabis pycnocarpa Hairy Rockcress	railroad ballast down New River on north side at Fayette Station 5-14-72

Spiraea virginiana Virginia spiraea	0.5 mile above Cotton Hill 6-9-54
	50 yards below Hawks Nest Dam 6-19-61
Desmodium lineatum Sticktights	dry roadbank near rim of canyon on southside -Fayetteville to Fayette Station Road 9-17-72
Desmodium pauciflorum Sticktights	Camp Brookside 8-14-58
	mountainside along path at Spring CA nearly 0.75 mile from west end of Hinton 8-2-41
Galactia volubilis Milk Pea	Camp Brookside along New River 9-26-71
	sandy areas of flood plain at Sewell 1973
	sandy openings at Corps of Engineers Camp near Prince 8-7-74
Polygala curtissii Curtiss' Milkwort	Nuttallburg 1890
Euphorbia humistrata Spreading Spurge	railroad ballast at Nuttallburg 1890
Euphorbia zinniflora Wolf's Milk	rock outcrops near McKendree 8-27-72
Ampelopsis cordata	near Cotton Hill 6-16-54
Lechea leggetti Pinweed	Gauley Mountain June 1901
Hypericum denticulatum Coppery St. John's-wort	rock outcrops at Gauley 11-9-74
	rock outcrops at Cotton Hill 8-13-72
Viola incognita Violet	near Hinton 4-8-32
Rhexia mariana Meadow Beauty	rock outcrops at Cotton Hill 8-11-73
Oenothera argillicola Shale Evening Primrose	near Hinton Aug. 1933

Rotala ramosior Toothcup	wet soil of rock ledges at Gauley 8-28-76
	wet riverbank below Hawks Nest Dam 9-14-76
Chaerophyllum teinturieri Teinturier's Chervil	opening by railroad at Ames 5-20-74
	railroad ballast at Gauley 4-27-75
Pseudotaenidia montana Mountain Pimpernel	near Hinton 4-19-32
Leucothoe recurvatus Recurved Fetterbush	from Hinton April 1941
Rhododendron viscosum White Swamp Honeysuckle	Hawks Nest Overlook June 1877 (verified in 1969)
Lysimachia vulgaris Golden Loosestrife	aquatic in bed of water-willows 9-17-67 (above Quinnimont)
Samolus parviflorus Water Pimpernel	below woodland spring 0.5 mile from west end of Hinton bridge 7-11-41
	margin of river at Gauley 11-9-74
Pycnanthemum loomisii Loomis' Mountain-mint	dry open field at Prince-Army Corps of Engineers Camp 8-6-72
Pycnanthemum torrei Torrey's Mountain-mint	Nuttallburg 9-19-1891
	rock outcrops at mouth of Keeneys Creek 7-23-67
Stachys hispida Hedge-Nettle	moist roadside near Dowdy Creek 7-9-72
Utricularia gibba Humped Bladderwort	brackish water hole in rock outcrops 8-18-74 (Gauley)
Antennaria virginica Shale Pussytoes	near Hinton May 1941
Aster linariifolius Stiff Aster	rock ledge at surge tank on Gauley 8-25-74
	New River at Gauley Station Sept. 1958

Coreopsis pubescens Tickseed	moist sand of flood plain near Prince 8-7-74
	flood plain at Cotton Hill 8-25-56
	moist sandy soil on Sewell flood plain 8-5-73
Eupatorium pilosum Vervain Thoroughwort	Nuttallburg 1898
	swamp at Washington Carver Camp 1973
Eupatorium hyssopifolium	railroad siding at Sewell 4-23-75
Helianthus dowellianus McDowell's Sunflower	Brooks 8-11-33
	Sewell floodplain 1973
	rock outcrops at Cotton Hill 9-17-72

References used as the primary sources for the rare and endangered plant summary are as follows:

1. Fortney, Ronald H., et. al. 1978. Rare and Endangered Species of West Virginia: A Preliminary Report - Volume I: Vascular Plants.
2. Grafton, William N. and Claude McGraw. 1976. The Vascular Flora of New River Gorge, West Virginia.
3. McGraw, Claude and William N. Grafton. 1973. The Vascular Flora of New River Gorge - Manns Creek - Fayette County, West Virginia.
4. Phillips, Violet Josephine Siemicozko. 1969. The Botany of the New River Valley between Glen Lyn, Virginia and Gauley Bridge, West Virginia.
5. Strausbaugh, P. D. and Earl L. Core. 1978. Flora of West Virginia.
6. US Department of Interior. 1980. Endangered and Threatened Wildlife and Plants - Native to the United States.

TIMBER RESOURCES

The "original forests", "lumber industry" and "present forest conditions" as described by A. B. Brooks (1911) were previously mentioned in the "Ecology of Forests, Cover Types, and Herbaceous Plants" section of this summary. Brooks' information dealt with Fayette County with no specific mention of New River Gorge.

The US Forest Service has periodically taken inventories of the quality and quantity of timber in West Virginia. These inventory results were published in 1949, 1953, 1964 and 1978. All data are given on either a statewide, region or county basis. Information dealing specifically with New River Gorge will have to be extrapolated from county figures. The 1978 survey notes changes and trends occurring since 1949. Various sections of the report deal with acreages, volumes, stand conditions, timber uses, growth, lumber and sawlog production and future trends. The following tables on commercial forest acreage (by ownership, stand-size and forest type), stocking, net volume by species, and land area classification by county exemplify the types of data available.

References used as the primary sources of this timber resources summary are as follows:

1. Brooks, A. B. 1911. Forestry and Wood Industries.
2. Northeastern Forest Experiment Station. 1978. The Forest Resources of West Virginia.
3. US Department of Interior- Bureau of Outdoor Recreation. 1975. New River Gorge.
4. West Virginia Department of Natural Resources. 1980. The Primary Forest Industry of West Virginia 1980.

Table 32.—*Area of commercial forest land in West Virginia, by ownership classes and geographic units, 1975*
(In thousands of acres)

Ownership classes	Northeastern	Southern	Northwestern	Total
National Forest	733.8	138.8	—	872.6
Other federal	14.0	3.1	22.0	39.1
State	88.1	78.7	62.1	228.9
County and municipal	.2	—	—	.2
Total public	836.1	220.6	84.1	1,140.8
Forest industry	234.5	491.5	153.7	879.7
Farmer-owned	876.0	391.5	660.1	1,927.6
Miscellaneous private:				
Individual	1,634.4	1,289.6	1,863.8	4,787.8
Corporate	402.8	1,254.1	95.4	1,752.3
Other	421.4	265.9	308.2	995.5
Total private	3,569.1	3,692.6	3,081.2	10,342.9
All ownerships	4,405.2	3,913.2	3,165.3	11,483.7

Table 33.—*Area of commercial forest land in West Virginia, by stand-size classes and geographic units, 1975*
(In thousands of acres)

Stand-size class	Northeastern	Southern	Northwestern	Total
Sawtimber stands	1,785.9	1,923.9	1,365.9	5,075.7
Poletimber stands	1,682.2	1,280.4	997.0	3,959.6
Sapling-seedling stands	852.4	662.0	791.7	2,306.1
Nonstocked areas	84.7	46.9	10.7	142.3
All classes	4,405.2	3.913.2	3,165.3	11,483.7

Table 34.—*Area of commercial forest in West Virginia, by forest types and geographic units, 1975*
(In thousands of acres)

Forest type	Northeastern	Southern	Northwestern	Total
White and red pine	31.3	69.9	—	101.2
Spruce-fir	58.5	.5	—	59.0
Virginia and pitch pine	187.5	48.2	249.5	485.2
Oak-pine	264.5	93.2	210.5	568.2
Oak-hickory	2,337.0	2,506.0	1,985.1	6,828.1
Elm-ash-cottonwood	392.2	156.6	265.7	814.5
Maple-beech-birch	1,125.3	1,038.8	454.5	2,618.6
Aspen-birch	8.9	—	—	8.9
All types	4,405.2	3,913.2	3,165.3	11,483.7

Table 37.—Number of growing-stock trees on commercial forest land, by species and diameter classes, Southern Unit, West Virginia, 1975

(In thousands of trees)

Species	All classes	Diameter class (inches at breast height)									
		5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Virginia pine	7,097	3,666	1,895	937	394	128	53	24	—	—	—
Other yellow pines	1,979	668	574	325	266	—	121	4	21	—	—
White pines	5,088	2,119	1,704	365	446	121	94	120	68	51	—
Red spruce	605	64	95	125	108	100	59	36	13	5	—
Hemlock	9,176	4,374	2,013	802	763	460	319	199	112	134	—
Total softwoods	23,945	10,891	6,281	2,554	1,977	809	646	383	214	190	—
Select white oaks[a]	37,795	15,291	9,110	5,181	3,397	1,923	1,384	794	377	309	29
Select red oaks[b]	25,304	5,667	5,941	4,743	2,665	2,261	1,678	929	617	737	56
Other white oaks[c]	44,439	20,605	9,738	5,163	2,853	2,322	1,355	933	657	738	75
Other red oaks[d]	43,700	15,216	9,867	6,615	3,346	3,801	1,897	1,195	808	884	71
Red maple	29,257	13,673	8,178	4,143	1,178	1,208	378	263	66	148	22
Sugar maple	22,279	10,441	5,827	3,070	1,168	824	300	211	177	229	32
Yellow birch	5,116	2,717	1,362	576	248	46	56	53	21	37	—
Sweet birch	14,460	8,211	3,262	2,060	517	208	12	61	83	46	—
Hickory	41,995	16,682	10,824	6,504	3,799	1,899	1,218	664	229	176	—
Beech	18,440	7,879	3,521	2,466	1,866	1,098	892	264	174	232	48
Ash	6,306	2,807	718	796	938	651	252	74	4	54	12
Black walnut	2,031	695	268	600	197	35	102	78	19	37	—
Yellow-poplar	43,850	13,366	9,450	7,415	5,131	3,931	2,355	1,258	555	382	7
Cucumbertree	6,832	1,903	2,428	909	773	362	301	87	69	—	—
Blackgum	4,447	2,396	819	299	93	317	166	128	63	166	—
Black cherry	5,249	2,433	825	612	502	450	240	75	56	56	—
Basswood	13,043	5,498	1,914	2,498	1,375	744	777	71	84	82	—
Other hardwoods	19,192	7,944	6,324	2,616	1,088	678	329	109	11	93	—
Total hardwoods	383,735	153,434	90,376	56,266	31,134	22,758	13,692	7,247	4,070	4,406	352
All species	407,680	164,325	96,657	58,820	33,111	23,567	14,338	7,630	4,284	4,596	352

[a] Includes only white oak trees.
[b] Includes only northern red oak trees.
[c] Includes only chestnut oak trees.
[d] Includes 27,141 thousand black oaks; 15,812 thousand scarlet oaks, and 747 thousand pin oak trees.

Table 53.—*Net volume of sawtimber on commercial forest land, by species and quality classes, Southern Unit West Virginia, 1975*
(In millions of board feet)[a]

Species	All classes	Standard-lumber logs			
		Grade 1	Grade 2	Grade 3	Grade 4[b]
Softwoods:					
White pine	124.1	7.3	23.5	62.6	30.7
Virginia pine	63.5	7.3	4.1	52.1	—
Other yellow pines	42.9	3.1	4.8	35.0	—
Other softwoods[c]	306.8	—	—	—	—
Total softwoods	537.3	17.7	32.4	149.7	30.7
Hardwoods:					
Select white oaks	947.2	65.2	172.1	458.7	251.2
Select red oaks	1,156.4	335.5	245.3	424.8	150.8
Other white oaks	969.9	108.4	214.5	391.2	255.8
Other red oaks	1,490.3	266.7	278.1	590.7	354.8
Red maple	367.2	61.2	64.7	131.9	109.4
Sugar maple	332.6	67.4	74.9	107.1	83.2
Yellow birch	43.1	6.1	7.1	23.4	6.5
Sweet birch	83.3	16.0	17.4	28.5	21.4
Hickory	856.0	103.2	143.3	343.7	265.8
Beech	542.6	67.9	85.4	227.1	162.2
Ash	186.5	28.1	42.6	79.1	36.7
Black walnut	60.1	2.8	15.4	36.3	5.6
Yellow-poplar	1,534.1	382.5	330.9	542.3	278.4
Cucumbertree	156.6	17.7	33.5	67.2	38.2
Blackgum	137.6	29.2	42.1	49.2	17.1
Black cherry	171.2	30.6	35.9	61.4	43.3
Basswood	34.1	4.6	7.8	15.9	5.8
Other hardwoods	242.0	10.4	42.5	130.9	58.2
Total hardwoods	9,310.8	1,603.5	1,853.5	3,709.4	2,144.4
			Percent		
Hardwood quality	100	17	20	40	23

[a] International 1/4-inch rule.
[b] Grade 4 applies only to white pine. For hardwoods the volumes in this column are for construction logs.
[c] Species other than pine are not graded into standard-lumber grades.

Table 57.—*Land area in West Virginia, by land classes, counties, and geographic units, 1975.*

County	Total land area[a]	Nonforest land area	Forest land		
			Non-commercial[b]	Commercial	Sampling error of total[c]
	Thousand acres				*Percent*
Boone	320.6	56.6	—	264.0	10
Clay	219.5	29.8	—	189.7	6
Fayette	424.3	84.7	3.9	335.7	5
Greenbrier	656.7	154.8	1.0	500.9	4
Kanawha	580.4	122.3	—	458.1	4
Logan	291.9	56.0	3.3	232.6	10
McDowell	341.1	64.1	—	277.0	11
Mercer	266.8	77.1	.5	189.2	6
Mingo	270.7	47.9	—	222.8	10
Monroe	302.5	116.5	—	186.0	8
Nicholas	416.0	78.4	.3	337.3	6
Raleigh	387.3	88.5	1.4	297.4	5
Summers	223.8	60.4	4.4	159.0	6
Wyoming	322.6	52.3	6.8	263.5	5
Southern Unit	5,024.2	1,089.4	21.6	3,913.2	1.8

Table 59.—*Area of commercial forest land in West Virginia, by forest type, county, and geographic unit, 1975*

(In thousands of acres)

County	Virginia and pitch pine	Other softwood types	Oak-hickory	Maple-beech-birch	Other hardwood types	All types
Boone	—	2.8	160.4	92.3	8.5	264.0
Clay	2.6	3.2	127.3	43.8	12.8	189.7
Fayette	4.9	4.4	225.2	78.1	23.1	335.7
Greenbrier	5.5	12.4	281.4	166.2	35.4	500.9
Kanawha	7.4	8.5	305.3	105.4	31.5	458.1
Logan	—	3.6	150.4	68.1	10.5	232.6
McDowell	—	4.6	174.0	81.8	16.6	277.0
Mercer	2.2	2.6	126.3	45.6	12.5	189.2
Mingo	—	3.3	139.8	68.7	11.0	222.8
Monroe	7.0	3.9	122.3	37.5	15.3	186.0
Nicholas	6.1	3.9	217.8	85.8	23.7	337.3
Raleigh	4.5	3.1	199.7	69.5	20.6	297.4
Summers	2.3	2.8	104.7	38.3	10.9	159.0
Wyoming	5.7	11.3	171.4	57.7	17.4	263.5
Southern Unit	48.2	70.4	2,506.0	1,038.8	249.8	3,913.2

Forest cover types occurring in the New River Gorge area have changed very little since the early 1900's when timbering reached its climax in the virgin forests. Brooks (1911) and other early authors noted the more common species. These coincide closely with the composition of cover types from the US Forest Service surveys of 1949, 1953, 1964 and 1978. Survey results indicate small decreases in acreages of pines, cove hardwoods and oak-hickory forest cover types and small increases in the northern hardwoods and aspen types.

The forests in the New River Gorge area generally coincide with the Appalachian Plateau Physiographic Province. These are principally hardwood forests of oak-hickory association interspersed with pine, cove hardwoods and other mixed mesophytic woodlands.

Major forest types in the total New River Gorge area by acreage include the following estimates: oak-hickory, 66,630 acres; maple-beech-birch, 17,090 acres; elm-ash-cottonwood, 3,780 acres; yellow-poplar, 2000 acres; loblolly-shortleaf, 1,830 acres; white pine, 1,000 acres; and oak-pine, 670 acres.

The scenic beauty of the Gorge owes much to the vegetation that grows there. In the early spring, the white dogwood and the pinkish redbud bloom, followed by the purple flowers of the imperial-tree, and in June and July, the white, pink and purple of the rhododendrons. In autumn, the foliage is even more impressive.

Still, it is the economic value of the timber that must be addressed. The species composition in New River Gorge is quite varied. The following list indicates that approximately 50 commercial tree species occur in the Gorge. The Imperial-tree should also be considered as having potential value. It should be noted that 10-15 species constitute a very high percentage of the timber cut commercially. Following the list of commercial trees is a listing of sawmills which depend partially on the timber resources of New River Gorge for their raw materials.

LIST OF COMMERCIAL TREE SPECIES OF WEST VIRGINIA

Scientific Name	Common Name	Occurence
Abies balsamea	Balsam fir	r
Juniperus virginiana*	Eastern redcedar	r
Picea rubens	Red spruce	r
Pinus echinata*	Shortleaf pine (Yellow)	r
P. pungens*	Table-mountain pine	r
P. resinosa	Red pine	r
P. rigida*	Pitch pine	r
P. strobus**	Eastern white pine	c
P. sylvestris	Scotch pine	vr
P. virginiana*	Virginia pine (Scrub)	c
Thuja occidentalis	Northern white-cedar	vr
Tsuga canadensis**	Eastern hemlock	c
Acer rubrum**	Red maple (Soft)	vc
A. saccharinum*	Silver maple	vr
A. saccharum**	Sugar maple (Hard)	vc
Aesculus species*	Buckeye	r
Betula alleghaniensis*	Yellow Birch	c
B. lenta*	Sweet birch (Black)	c
B. nigra *	River birch (Red)	vr
B. papyrifera	Paper birch (White)	vr
Carya species**	Hickory	vc
Castanea dentata*	American chestnut	r
Celtis occidentalis*	Hackberry (Sugar berry)	r
Cornus florida*	Flowering Dogwood	c
Diospyros virginiana*	Common persimmon	r
Fagus grandifolia**	American beech	c
Fraxinus species**	Ash	c
Gleditsia triacanthos*	Honeylocust	vr
Ilex opaca*	American holly	vr
Juglans cinerea*	Butternut	r
J. nigra**	Black walnut	c
Liquidambar styraciflua*	Sweetgum	vr
Liriodendron tulipifera**	Yellow-poplar (Tuliptree)	vc
Magnolia species**	Magnolia	c
Nyssa sylvatica**	Blackgum (Tupelo)	c
Platanus occidentalis**	Am. sycamore (Buttonwood)	r
Populus deltoides*	Eastern cottonwood	vr
P. grandidentata*	Bigtooth aspen (Popple)	r
P. tremuloides	Quaking aspen (Trembling)	r
Prunus serotina**	Black cherry	c
Quercus alba**	White oak (Stave)	vc
Q. bicolor	Swamp white oak	vr
Q. coccinea**	Scarlet oak	c
Q. imbricaria	Shingle oak	vr
Q. macrocarpa	Bur oak	vr
Q. muhlenbergii*	Chinkapin oak	vr
Q. palustris	Pin oak	vr
Q. prinus**	Chestnut oak (Rock)	vc
Q. rubra**	Northern red oak	c
Q. stellata*	Post oak	r
Q. velutina**	Black oak (Yellow bark)	c
Robinia pseudoacacia**	Black locust	c
Salix nigra*	Black willow	vr
Tilia americana**	American basswood	c
Ulmus species**	Elm	c

* Occurs in the Gorge ** Important commercially

FAYETTE COUNTY

COMPANY NAME AND ADDRESS	MILL TYPE	SIZE CLASS	PRODUCTS PURCHASED	PRINCIPLE SPECIES	PRODUCTS AND BY-PRODUCTS
Eastern Hardwoods, Inc. Mount Hope, WV 25880	Circle	5 MM	Stumpage	Mixed hwds	Grade lumber, Ties, Chips Bark, Sawdust
Fayette Lumber Co., Inc. Dixie, WV 25059	Circle	2 MM	Stumpage Sawlogs	Mixed hwds	Lumber, Ties, Timbers, Slabs, Edgings
Moodespaugh, Bruce P.O. Box 95 Cranberry, WV 25828	Circle	2 MM	Stumpage Sawlogs	Mixed hwds	Lumber Ties, Timbers
Reed, Orval Lumber Co. P.O. Box 632 Ansted, WV 25812	Circle	1 MM	Stumpage	Mixed hwds	Lumber Chips, Bark

RALEIGH COUNTY

J. P. Hamer Lumber Co. P.O. Box 83 Sundial, WV 25189	Band	5 MM	Stumpage Sawlogs	Mixed hwds	Lumber, Chips, Sawdust
Link Lumber Co. Box 236 Daniels, WV. 25832	Circle	2 MM	Stumpage Sawlogs	Mixed hwds	Mine materials, Lumber, Chips, Sawdust
Meadows, Denvil Pluto Route, Box 64 Hinton, WV 25951	Circle	100M	Sawlogs	Mixed hwds	Mine materials

COMPANY NAME AND ADDRESS	MILL TYPE	SIZE CLASS	PRODUCTS PURCHASED	PRINCIPLE SPECIES	PRODUCTS AND BY-PRODUCTS
Abshire Lumber Co. Jumping Branch, WV 25969	Circle	500M	Stumpage	Mixed hwds	Ties, Timbers
Blue Valley Lumber Co. Route 1, Box 47 Meadow Bridge, WV 25976	Circle	1 MM	Stumpage	Mixed hwds	Lumber, Timbers Mine materials
Bowles, Earl Box 104 Sandstone, WV 25985	Circle	100M	Stumpage Sawlogs	Mixed hwds	Lumber Mine materials
Farley, Hollis Rt. 86, Box 63 Jumping Branch, WV 25969	Circle	100M	Stumpage	Mixed hwds	Lumber Mine materials
Gwinn Lumber Co. Green Sulphur Springs, WV 24729	Circle	100M	Own Stumpage	Mixed hwds	Ties, Timbers

MAMMALS

The mammals of West Virginia have been of considerable importance to man since he first occupied the State. They were essential to the existence of the Indians and white settlers, for it was the mammals which provided most of the food and part or all of the clothing of these early people. The large herbivores were especially important in this respect. The large carnivores were a constant threat to the domestic stock of the early settlers and were considered, perhaps unduly, a threat to the settlers themselves.

Local histories and the journals of early explorers mention only the larger species. It is only from these sources that we may obtain our information, since most of them have been extirpated within the State.

In 1911 F. E. Brooks published an account on the abundance and distribution of 58 species and subspecies of mammals which were known or believed to have lived in the State. Surber collected mammals in West Virginia for about 20 years and, in his annotated list published in 1912, recorded 57 species and subspecies which had been present or were still living in the State. The number was increased to 62 by A. B. Brooks (1929). Kellogg, in his "Annotated Check List of West Virginia Mammals" (1937), lists 73 recent forms.

In 1948 the WV Conservation Commission initiated a mammal survey. The project began in 1949 and was completed in 1951 under the direction of Sturgis McKeever. Field work on the mammals was done to obtain information concerning the ecology, distribution, biology and correct identification of West Virginia's mammals. Specimens collected prior to this survey by individuals and museums were also included in this study. The literature was surveyed for historical comments, natural history and life history information. The survey identified 69 species consisting of 78 subspecies. Mammals with a northern affinity totaled 34 as versus 32 with a southern affinity. Three mammals are introduced within recent times. The three are the Norway rat, black rat and house mouse. Their only importance is as pests.

Mammals found throughout West Virginia are as follows:

Smoky shrew	Least weasel	Long-tailed weasel
Hairy-tailed mole	Mink	Short-tailed shrew
Silver-haired bat	Norway rat	Little brown bat
Woodchuck	House Mouse	Trouessart's bat
Chipmunk	Opossum	Big brown bat
Southern flying squirrel	Least shrew	Eastern cottontail
Beaver	Pipistrel	Gray squirrel
Lemming mouse	Red bat	White-footed mouse
Muskrat	Hoary bat	Striped skunk
Meadow mouse	Gray fox	White-tailed deer
Woodland jumping mouse	Raccoon	
Red fox		

Mammals with a limited range which should include New River Gorge are as follows:

Star-nosed mole	Indiana bat
Meadow jumping mouse	Harvest mouse
New England cottontail	Wood rat

The factor controlling the local distribution of most rodents and lagomprphs is life form of the vegetation. The local distribution of some carnivores is also controlled by vegetative life forms. Changes in the life form over extensive areas may result in a marked increase or decrease of the overall distribution of some mammals.

Five mammals are listed on the most recent list of endangered species as possibly occurring in West Virginia. The mammals and their ranges are as follows:

Indiana bat	East and midwestern US
Virginia big-eared bat	KY, WV, VA, IN, IL, OH
Brown or grizzly bear	48 conterminous states
Gray wolf	48 conterminous states
Eastern cougar	Eastern US

None of these mammals have been seen in the New River Gorge in recent decades. The brown or grizzly bear has never been officially recorded for the State. The bats have been recorded from the nearby cave region of Greenbrier and Monroe Counties. Thus, the chances of their occurrence in New River Gorge is possible. Gray wolf and eastern cougar have been extinct in West Virginia since the early 1900s but might immigrate into West Virginia and the New River Gorge in the future.

The following population trends for the larger game species in New River Gorge are predicted by the Wildlife Resources Division of the WV Department of Natural Resources. Deer populations in the area are fair and appear to be growing. The large acreage of abandoned strip mines in the area has apparently provided a sufficient quantity of good browse to help support this population. Black bear are seen in the area and their numbers are increasing. A variety of small upland game (squirrel, rabbit, fox, raccoon, & woodchuck) occur in large quantities.

The impact of hunting in the counties included in this study are as follows:

Wild Turkey (number of birds killed)

	1975	1976	1977	1978	1979
Fayette	1	2	4	3	7
Raleigh	0	0	2	2	0
Summers	4	7	5	21	32

Black Bear

No black bear were legally killed in the New River Gorge in 1979. However 2 bear were illegally killed in Fayette County in 1979. Bear damage claims and sightings for 1979 for Fayette, Raleigh and Summers Counties were 14, 18 and 4 respectively.

White-tailed Deer (number of deer harvested)

	1977	1978	1979
Fayette	139	165	168
Raleigh	46	73	64
Summers	203	270	278

Bobcat (number trapped)

	1979
Fayette	38
Raleigh	32
Summers	24

Beaver (number trapped)

	1975	1976	1977	1978	1979
Fayette	14	11	3	60	41
Raleigh	-	1	20	12	16
Summers	12	9	2	-	9

Management of mammals in West Virginia is very limited. Management in New River Gorge is non-existent except for legal regulation on bag limits and numbers of animals which can be harvested. There has been no manipulation of habitats or vegetation for the purpose of wildlife management.

Habitat requirements and management strategies are known for all game species. Most of New River Gorge is forested. Manipulation of the dominant vegetative cover would determine which mammals would increase in numbers. The dominant vegetation greatly determines potential wildlife management. The biggest gap in information is that very little detailed information exists on the non-game species of mammals of West Virginia.

An excellent summary of wildlife resources and management is contained in the US Forest Service's 1978 publication "The Forest Resources of West Virginia" on pages 24-28. These are included herein.

Wildlife resource is varied

The climate, topography, and geology of an area influence the composition of the plant community, and the nature and abundance of the local vegetation, in turn, influence the kinds of wildlife that an area can support. West Virginia is unique among the eastern states. The State is the meeting ground for typically northern and southern flora and fauna and thus provides a wider variety of plant and animal life than most other states. The Allegheny Mountains which bisect the State are covered with the northern hardwood and spruce-fir forests that are characteristic of the forests further north. The eastern slopes of these mountains are predominatly oak-pine and the western slopes and lower elevations are dominated by the oak-hickory forests typical of the central hardwood region.

Past human influences. As man made his imprint on the landscape certain environmental changes occurred which radically affected the compositon of the wildlife population. Thus, as West Virginia was transformed from a wilderness to its present state there have been significant changes in the composition and abundance of the native wildlife. The bison, eastern cougar, river otter, elk, wolf, passenger pigeon, and sturgeon, once indigenous to West Virginia, have been extirpated (W. Va. Dep. Natural Resources 1974). Few of these native wildlife species were purposely exterminated by man. Most were victims of habitat destruction by land filling and clearing, siltation and pollution, wildfires and erosion, and other massive man-made environmental changes.

Most fish and wildlife are sensitive to environment change. As mature forests are cleared, natural watercourses changed, wetlands drained, and streamflows and temperatures altered the quantity and quality of the food, water, and cover for the native fish and wildlife are immediately affected. Some man-made changes may be beneficial to wildlife. Opening up the native vegetation as the State was settled, providing a good balance of mature forests, regenerating forests, and open spaces, increased the food supply and encouraged ever-increasing populations of such "edge" species as deer, grouse, and cottontail rabbits (U.S. Forest Service 1970). The deer population in West Virginia in the early 1900's was estimated at about 1,000 animals. The white-tailed deer harvested by gun alone in 1974 numbered nearly 24,000. In addition, over 2,000 deer were harvested during bow-hunting season and 4,000 were known to have been killed illegally or accidently.

The populations of certain "interior species", such as gray squirrels, turkeys, and snowshoe hares, have been reduced over the years as the mature timber stands of the State were converted. A striking example of population reduction that resulted from habitat reduction is that of the snowshoe hare, whose range is limited to the spruce-fir type about 3,000 feet elevation in the Allegheny Mountains. Originally this forest type occupied 469,000 acres of West Virginia high country (Core 1966). Over the years its extent has been drastically reduced, first by clearcutting and later by repeated burning, until today it covers less than 60,000 acres.

Wildlife resource requirements. The maintenance and perpetuation of the wildlife resource is important to most West Virginians. Many rural residents consider hunting and fishing an essential part of the agricultural harvest and the major form of recreation available to them. Urban dwellers value the closeness of good hunting and fishing. They spend a sizeable portion of their discretionary income each year on hunting and fishing licenses and equipment.

The following statistics present the past and expected future growth in number of resident and nonresident licensed hunters and fishermen in West Virginia:

Year	Hunters			Fishermen		
	Resident	Nonresident	Total	Resident	Nonresident	Total
	(Thousands of licensees)					
1960	211.6	7.9	219.5	148.9	9.0	157.9
1965	224.1	13.0	237.1	187.8	22.6	210.4
1970	234.2	22.8	257.0	219.2	33.4	252.6
1973	232.6	25.9	258.5	222.5	23.3	245.8
1980[a]	239.0	30.0	269.0	230.0	34.0	264.0
1990[a]	244.0	36.0	280.0	241.0	40.0	281.0
2000[a]	252.0	44.0	296.0	256.0	48.0	304.0

[a] Estimates based on past trends.
Source: 1960-1973 Statistics; West Virginia Div. of Wildlife Resources.

Demand for wildlife resources has been growing over the years. Resident hunting and fishing license sales increased 11 percent and 47 percent respectively from 1960 to 1970. More important, however, is the increase in nonresident license sales. The 7,900 hunting licenses that were purchased by nonresidents in 1960 represented less than 4 percent of total sales. In 1973, the 25,900 nonresident hunting licenses purchased represented more than 10 percent of total sales. If these trends continue, an estimated 296,000 hunting licenses and 304,000 fishing licenses will be purchased by the year 2000. About 15 percent of the total will be purchased by nonresidents.

A hunting use survey in 1970 (Riffe 1971) indicated the type of forest game animals that hunters preferred to hunt. Most popular among the respondents were squirrels, followed by deer, ruffed grouse, wild turkey, raccoon, bear, woodcock, and snowshoe hare. In addition, cottontail rabbits are a highly regarded game animal on agricultural land. Trout is the most popular forest-game fish.

These preferences are supported by 1970 statistics (West Virginia Dept. Natural Resources, 1974) that show the number of licensed hunters that hunted these game species and the number of days they spent hunting them.

Species	Hunters	Days hunted
White-tailed deer	145,935	630,620
Wild turkey[a]	61,413	215,276
Ruffed grouse	76,000	445,000
Bobwhite quail	19,180	91,275
Mourning dove	5,443	33,868
Woodcock	15,000	26,000
Cottontail rabbit	128,000	900,000
Squirrels	178,624	1,247,600
Raccoon	17,000	162,000
Foxes	12,568	62,504

[a] Includes two season; fall 1970 and spring 1971.

Nearly 179,000 licensed hunters spent 1.2 million hunter-days hunting for squirrels in West Virginia. Based on number of hunters, white-tailed deer and cottontail rabbit ranked second and third. Based on number of hunter-days, cottontail rabbit and white-tailed deer ranked second and third. Nearly 894,000 angler-days were devoted to trout fishing in 1970. This represented 15.7 percent of the total licensed fishing effort statewide.

The West Virginia Wildlife Division has made projections of the total number of days that will be expended by hunters and anglers in the pursuit of game animals and fish, based on previous activity. Statewide projected demand in number of hunter and angler days of recreation is:

	1980	*1985*	*1990*
Hunter-days	4,937,000	5,480,000	6,033,000
Angler-days	2,616,000	2,819,000	3,023,000

Wildlife habitat management. These sportsmen's preferences along with the acreage and general condition of the game habitat are important to consider when planning game management programs. Statistics generated during the State's 1975 timber survey provide insight into the character of the existing vegetation in the various cover types and their relative productivity, and when compared to previous surveys reveal important vegetational changes.

Cover type	Character of vegetations			Relative productivity for wildlife[a]
	Mature timber	Immature timber	Open	
	(Million acres)			
Oak-hickory	1.9	2.7	0.1	H
Mixed Appalachian hardwoods	1.2	1.6	—	H
Northern hardwoods	1.6	1.0	[b]	M
White and red pine	[a]	.1	—	L
Virginia pine	.2	.3	—	M
Spruce-fir	[b]	[b]	[b]	L
Elm-ash-cottonwood	.2	.6	—	M
Pasture	—	—	1.4	M
Cropland	—	—	.5	L
Total	5.1	6.3	2.0	

[a] L = Low; M = Medium; and H = High. Ratings were adapted from U.S. Dep. Agric. Forest Service General Technical Report NE-12.

[b] Fewer than 50,000 acres.

With a knowledge of specific wildlife habitat requirements and of the character of the vegetation available at any point in time, crude estimates can be made of the prime habitat acreage that is available. The following compilation gives the current acreages of prime habitat that are available to some of the important West Virginia game species.

Species	Prime habitat[a]
Big game:	(Million acres)
White-tailed deer	8.0
Black bear	2.5
Wild turkey	4.0
Upland game birds:	
Ruffed grouse	7.4
Bobwhite quail	5.8
Ring-necked pheasant	.1
Mourning dove	1.4
Woodcock	.8
Upland game mammals:	
Cottontail rabbit	6.6
Snowshoe hare	.1
Squirrel	7.2

[a] Indicates acreage of cover present that should furnish adequate habitat based on known specie preferences. Does not consider such factors as remoteness or human population density.

Large acreages of prime habitat are currently available to several game animals. This is only partially the result of current land use. Superior environmental adaptability and high mobility also affect the prime habitat acreage. The habitat available to the Bobwhite quail, for example, is limited because their habitat is specific (early plant communities with abundant seed-producing weeds). White-tailed deer, on the other hand, are adapted to many types of vegetative cover as long as the cover is varied. Deer also range over large territories to satisfy their basic needs.

Recent research (Gill, Thomas, et al. 1975) into the relative carrying capacity of seven forest cover types in West Virginia, based on repeated observations of game occurrence, has provided forest land managers with a tool to assist them in developing those timber and wildlife management strategies that are most beneficial for both resources. A comparison of these numerically rated forest type/game relationships allows the systematic consideration of management alternatives and measures the relative magnitude of the trade-offs that might result from management prescriptions.

Management implications of land-use trends. Agriculture, as practiced on the family farm, has been declining in the last quarter century, and as a result, the area in forest cover has been increasing. Statewide, the commercial forest land area has in-

creased from 64 percent of the total land area in 1949 to 74 percent in 1975. Although the State's Northwestern Unit experienced the greatest increase in commercial forest area (up 43 percent), it is still the least forested portion of the State (71 percent). The Southern Unit, which has the greatest percentage of forest cover (78 percent), had the smallest percentage increase (up 1 percent). The Northeastern Unit, which is 74 percent forested, experienced a 17 percent increase.

Abandoned farms and their pastureland are reverting to forest. As grasslands disappear, so do the grassland-dependent species of animal life. They are replaced by animals of the thicket; and these in turn will be replaced by forest-dwelling animals. Over much of the State, selectively harvested forests are closing as young growth fills in the openings around the less desirable and highly defective residual trees. The value of these stands for white-tailed deer is declining, but is improving for the wild turkey and the gray squirrel. Thus, as the plant communities change over time, so do the animals; for each is closely tied to the other.

Habitat requirements and some of the management strategies that may be initiated to improve the local habitat for some of West Virginia's important game animals are listed:

Game species	Habitat requirements and special problems	Positive management strategies
Big Game:		
White-tailed deer	Flourishes in managed young-growth mixed hardwoods in various stages of development interspersed with active farms. Winter food supply, urban development, uncontrolled dogs, and hunter access affect population level.	Control deer population distribution by special hunts. Encourage hunter access to private lands.
Black bear	Requires extensive roadless areas with little human activity.	Administratively reserve existing prime habitat on public lands. Maintain current population levels through controlled harvests.
Wild turkey	Flourishes in mature oak-hickory and northern hardwood stands. Short-rotation timber harvesting and conversion to softwood types is detrimental to increasing population.	Long-rotation timber practices that favor retention of mast-producing trees enhance food supply. Controlled hunts in high population counties maintain good bird distribution.
Upland game birds:		
Ruffed grouse (White 1968)	Prefers early successional plant communities created by timber harvesting, farmland abandonment, restored surface mining, or burning.	Short-rotation timber management. Provide for a variety of human disturbances that will ensure sufficient habitat.
Bobwhite quail	Prefers early successional plant communities created by periodic disturbances.	Provide required habitat by prescribed burning, timber harvest, moderate grazing, raising grain crops.
Mourning dove (Goudy 1975)	Prefers extensive areas of grain crops.	Reverse trend of converting cropland to grassland in West Virginia.

CONTINUED

Continued

Game species	Habitat requirements and special problems	Positive management strategies
Woodcock	Prefers moist areas with brush or low woody vegetation. Dams, stream channelization, intensive agriculture, and pesticides are detrimental.	Encourage greater hunting pressure. Provide early successional plant communities.
Upland game mammals:		
Cottontail rabbits	Prefers early brush vegetative stages dominated by herbaceous vegetation and vines. Herbicide use and progression into sapling state of succession are detrimental.	Short-rotation, even-age harvesting systems, and prescribed burning.
Snowshoe hare	Prefers dense, high-elevation stands of conifer types (above 3,000 feet) interspersed with thickets of shrubs. Large acreages have been converted to northern hardwood types.	Management practices that promote restoration of hardwood stands to conifers.
Squirrels	Prefers mature mast-bearing stands of oak-hickory type. Short rotations and even-aged management are detrimental to nut production and shelter.	All-age management practices that favor mast-producing trees and retain den trees.

References which provided the major portion of the mammal summary are as follows:

1. Adkins, James R., et. al. 1976. Comprehensive Survey of the New River Basin (Volume I- Inventory).
2. McKeever, Sturgis. 1954. Ecology and Distribution of the Mammals of West Virginia.
3. Northeastern Forest Experiment Station. 1978. The Forest Resources of West Virginia.
4. US Department of Interior - Bureau of Outdoor Recreation. 1975. New River Gorge.
5. US Department of Interior. 1980. Endangered and Threatened Wildlife and Plants - Native to the United States.
6. WV Department of Natural Resources. 1980. Big Game Bulletin - 1979.

BIRDS

There have been no actual studies made in the New River Gorge to determine the ecology of the bird life of the area or to make a list of the birds found living there.

There have been two field surveys of birds done within close proximity of, and including a very small portion of the Gorge area. These two studies were conducted by the Brooks Bird Club. The first was in Fayette County in 1954 and the second was in Raleigh County in 1975. The Brooks Bird Club conducts systematic field surveys annually in various locations throughout the state of West Virginia.

For this summary, a list of what is probably the more common and fairly common birds of the New River Gorge has been drawn from the results of the above mentioned field surveys of the Brooks Bird Club since this is the only information specific to New River Gorge. More detailed information on the field survey methods and results can be obtained through the quarterly publication of the BBC known as the Redstart.

Some of the more common birds include:

Red Tailed Hawk	Red Shouldered Hawk
Broadwinged Hawk	Bobwhite
Yellow Billed Cuckoo	Turkey Vulture
Screech Owl	Barred Owl
Whip-poor-will	Chimney Swift
Ruby Throated Hummingbird	Belted Kingfisher
Yellow Shafted Flicker	Pileated Woodpecker
Crested Flycatcher	Eastern Phoebe
Acadian Flycatcher	Eastern Wood Peewee
Rough Winged Swallow	Blue Jay
Crow	Carolina Chickadee
Tufted Titmouse	White Breasted Nuthatch
Carolina Wren	Catbird
Brown Thrasher	Robin
Wood Thrush	Eastern Bluebird
Blue Gray Gnatcatcher	Cedar Waxwing
Starling	White Eyed Vireo
Red Eyed Vireo	Black and White Warbler
Golden Winged Warbler	Parula Warbler
Yellow Warbler	Caerulean Warbler
Chestnut Sided Warbler	Ovenbird
Louisiana Waterthrush	Kentucky Warbler
Yellow Throat	Yellow Breasted Chat
Hooded Warbler	Redstart

Eastern Meadowlark	Baltimore Oriole
Cowbird	Scarlet Tanager
Summer Tanager	Cardinal
Indigo Bunting	Goldfinch
Red-eyed Towhee	Chipping Sparrow
Field Sparrow	Song Sparrow

The species listed above would be distributed throughout the New River Gorge area in relation to the distribution and abundance of the habitats they prefer. A good ornithological handbook will provide the preferred habitat information.

Bird species that are not particularly common in the New River Gorge area are as follows:

Green Heron	Sharp Shinned Hawk
Cooper's Hawk	Killdeer
Hairy Woodpecker	Cliff Swallow
Worm-eating Warbler	

Species which have been sighted in the area but are considered rare for New River Gorge are the Rose Breasted Grosbeak (Occurs more frequently at higher elevations), Canada Warbler and Swainson's Warbler. The Osprey has also been sighted along New River.

Some of the habitat requirements and management strategies for game birds (ruffed grouse, wild turkey, bobwhite quail, mourning dove and woodcock) are given on pages 87 and 88 of this summary.

References which provided the major sources of information included in this summary are as follows:

Bell, Ralph K. 1976. The 1975 Foray Bird List

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US Department of Interior. 1980. Endangered and Threatened Wildlife and Plants- Native to the United States.

FISHES

Stauffer, et. al. (1980) conducted an inventory of the fishes in the New River Gorge. As a result, the US Department of Interior identified 23 species of plants and animals as endemic to the New River region (watershed). Included in the Gorge area were five species of fish: Nocomis platyrhynchus (bigmouth chub); Notropis scabriceps (New River shiner); Phenacobius teretulus (Kanawha minnow); Etheostoma kanawhae (Kanawha darter) and Etheostoma osburni (finescaled saddled darter). Additionally, an undescribed relative Percina cf maculata to the blackside darter P. maculata, is native to Kanawha River below the falls and the greater Ohio River drainage. Of these species, all were collected in the 1980 survey except for P. teretulus and E. kanawhae.

Distribution of these species is given in the above study. The bigmouth chub is widely distributed in the New River system. The New River shiner is well distributed in the upper New River drainage, as well as the Gauley and Greenbrier River. The Kanawha minnow has been recorded in the Gauley and Greenbrier Rivers. The finescaled darter is common in the Bluestone, Gauley and Greenbrier River.

The various falls in New River have long been recognized as barriers to the spread of different fishes. Kanawha Falls is felt to be a major barrier. However, it is possible the fishes of Gauley River could inhabit the lower part of New River. Hocutt, et. al. (1978) studied the fishes of the Gauley River in 1978 and reported several new records which could be important if the New River Gorge National River is expanded to Gauley Bridge.

The following table list the various species of fish known to occur in the New River between Claytor Lake, Virginia, downstream to the confluence of and including the Gauley. The insufficient amount of studies have caused Stauffer (1980) and others to conclude that any of these species could occur in any part of the New River (including the Gorge).

List of Fishes Known from New River and Gauley River based on Hocutt, et. al. (1978 and 1979) and WV-DNR Reports

Petromyzontidae

Lampetra aepyptera - Least brook lamprey

Clupeidae

Alosa pseudoharengus - Alewife
Dorosoma petenense - Threadfin shad

Amiidae

Amia calva - Bowfin

Anguillidae

Anguilla rostrata - American eel

Esocidae

Esox masquinongy - Muskellunge
Esox lucius - Northern pike
Esox lucius x masquinongy - Norlunge
Esox niger - Chain pickerel

Salmonidae

Salmo gairdneri - Rainbow trout
Salmo trutta - Brown trout
Salvelinus fontinalis - Brook trout

Cyprinidae

Campostoma anomalum - Stoneroller
Clinostomus funduloides - Rosyside dace
Cyprinus carpio - Carp
Ericymba buccata - Silverjaw minnow
Exoglossum laurae - Tonguetied minnow**
Exoglossum maxillingua - Cutlips minnow
Hybopsis dissimilis - Streamline chub
Nocomis leptocephalus - Bluehead chub
Nocomis platyrhynchus - Bigmouth chub*
Notemigonus crysoleucas - Golden shiner
Notropis albeolus - White shiner
Notropis ardens - Rosefin shiner
Notropis cerasinus
Notropis chrysocephalus - Striped shiner
Notropis galacturus - Whitetail shiner
Notropis hudsonius - Spottail shiner
Notropis photogenis - Silver shiner
Notropis procne
Notropis rubellus - Rosyface shiner
Notropis scabriceps - New River shiner**
Notropis spilopterus - Spotfin shiner
Notropis st mineus - Sand shiner
Notropis telescopus - Telescope shiner
Notropis volucellus - Mimic shiner

* Endemic ** Endemic of special concern to WV-DNR

Cyprinidae (cont'd)

Phenacobius teretulus - Kanawha minnow**
Phoxinus oreas - Mountain redbelly dace
Pimephales notatus - Bluntnose minnow
Pimephales promelas - Fathead minnow
Rhinichthys atratulus - Blacknose dace
Rhinichthys cataractae - Longnose dace
Semotilus atromaculatus - Creek chub

Catostomidae

Catostomus commersoni - White sucker
Hypentelium nigricans - Northern hog sucker
Moxostoma erythrurum - Golden redhorse
Moxostoma rhothoecum - Torrent sucker

Ictaluridae

Ictalurus furcatus - Blue catfish
Ictalurus melas - Black bullhead
Ictalurus nebulosus - Brown bullhead
Ictalurus punctatus - Channel catfish
Ictalurus flavus - Yellow bullhead
Noturus insignis - Margined madtom
Noturus flavus - Stonecat
Pylodictus olivaris - Flathead catfish

Atherinidae

Labidesthes sicculus - Brook silverside

Percicthyidae

Morone chrysops - White bass
Morone saxatilus - Striped bass
Morone chrysops x saxatilus - Sunshine bass

Centrarchidae

Ambloplites rupestris - Rock bass
Lepomis auritus - Redbreast sunfish
Lepomis cyanellus - Green sunfish
Lepomis gibbosus - Pumpkinseed
Lepomis gulosus - Warmouth
Lepomis macrochirus - Bluegill
Lepomis megalotis - Longear sunfish
Micropterus dolomieui - Smallmouth bass
Micropterus punctatus - Spotted bass
Micropterus salmoides - Largemouth bass
Pomoxis annularis - White crappie
Pomoxis nigromaculatus - Black crappie

Percidae

Etheostoma blennioides - Greenside darter
Etheostoma caeruleum - Rainbow darter
Etheostoma flabellare - Fantail darter
Etheostoma kanawhae - Kanawha minnow*
Etheostoma nigrum - Johnny darter
Etheostoma osburni - Finescale saddle darter*
Perca flavescens - Yellow perch
Percina caprodes - Logperch
Percina cf maculata - Blackside darter
Percina ~~maculata type (being described)~~** gymnocephala Appalachia darter
Percina oxyrhyncha - Sharpnose darter
Percina roanoka - Roanoke darter
Stizostedion vitreum - Walleye pike

per telecon w/ Dan Cincotta - DNR 9/24/82

Cottidae

Cottus bairdi - Mottled sculpin
Cottus carolinae - Banded sculpin*

The following game species are found in the New River:

Brook trout	Rock bass
Brown trout	Muskellunge
Rainbow trout	Walleye
Golden trout	White crappie
Largemouth bass	Black crappie
Spotted bass	Channel catfish
Smallmouth bass	Flathead catfish
White bass	All sunfish

The New River produces some of the best bass fishing in the state, especially smallmouth bass. In 1970, an estimated 12 percent of all bass caught in West Virginia came from the New River. It also is noted for excellent walleye fishing. Hawks Nest Lake produces good bass and catfish fishing. Many fishing records have been broken by anglers reeling in game fish from Sandstone Falls and below in the New River Gorge. However, the rugged terrain and turbulent waters restrict the number of people visiting this part of the river. The mainline tracks of the C & O Railroad, which run parallel to the river inside the Gorge, offer access to the more energetic fishermen. The roads leading to the river are on private land and usually require the use of a four-wheel vehicle. Except under very favorable conditions, the numerous rapids hinder the employment of boats.

The table below gives pertinent statistics for fishing on the New River in 1970. Other than increases for a greater population, these figures are a useable estimate for 1980.

New River Fishing Pressure

Species	Estimated No. of Fishermen	Estimated No. Days Fished	Estimated No. Fish Caught	Estimated No. Fish Kept
Bass	18,557	161,267	346,648	169,357
Trout	7,761	40,363	77,963	59,518
Catfish	16,789	131,176	218,690	159,931
Walleye	1,658	20,249	3,325	2,097
Musky	275	4,343	2,419	1,484
Panfish	9,178	84,548	209,676	72,292
Other	4,965	47,590	52,345	39,011

An excellent general summary of fish resources and management in West Virginia is contained in the United States Forest Service's 1978 publication, "The Forest Resources of West Virginia" on pages 28 through 30. Management strategies in the New River Gorge will definitely involve "cold-water streams" and "warm-water rivers". Should the New River Gorge National River be expanded to include the lower stretches of New River, management would include the Hawks Nest resevoir. Pages 28-30 from "The Forest Resources of West Virginia" are herein included as pertinent information.

Fish resource management

The natural diversity of West Virginia streams and rivers originally provided habitat for a wide range of fish species. As settlement proceeded and the mineral and timber resources were exploited, uncontrolled wildfires occurred and the distribution of the original fish resources was altered. Also, large power and flood control dams were constructed that created large man-made impoundments on some of the major rivers. Current management programs are centered in three main areas: cold water streams, warm water rivers and waterways, and reservoirs and small impoundments.

Cold-water streams. Present cold-water management efforts are focused on the protection and perpetuation of three trout species. Brook trout, a West Virginia native, was originally found in the headwaters of most of the State's rivers. Rainbow and brown trout were introduced. Hatchery records (W. Va. Dept. Natural Resources 1973) show that rainbow trout were introduced into West Virginia streams from the Federal hatchery at White Sulphur Springs in 1903 and that brown trout were introduced in the 1930's.

Fishery managers estimate that there are about 7,580 miles of fish-supporting habitat along the 8,000 streams that drain water from within the State's boundaries (W. Va. Dept. of Natural Resources 1973). About 710 miles of this is cold water fish habitat and 564 miles is known to be supporting populations of native brook trout. In addition, hatchery-raised rainbow and brown trout are living and reproducing along about 26 miles and 10.5 miles of cold water streams respectively. Fishery biologists say that the existing cold water fish habitat could be extended by 144 miles if current pollution levels could be abated.

Problems that effect trout populations can be either physical or chemical. Vegetation removal and stream disturbances can result in widely fluctuating stream-flow, high water temperatures, and sedimentation. Surface runoff carries soil particles and nutrients into the streams. The fine particles produce turbidity, which enhances the absorption of solar energy by the water, raises its temperature, and depletes its oxygen. These changes reduce the trout population. As the soil particles settle, they form a sediment over the stream bottom that chokes off necessary bottom-dwelling organisms and smothers the year's pro-

duction of trout eggs. Chemical problems are more subtle. Acid mine drainage causes the most serious chemical problems in West Virginia streams, but high total heavy-metal levels have also been know to hamper trout reproduction and diminish oxygen and natural food supplies. The full effects of acid rainfall from industry centers in neighboring states have yet to be evaluated.

West Virginia's trout stocking program is the State's most important ongoing recreation fishing program and accounted for about 40 percent of the total expenditures of fish management funds in 1971. Based on total poundage, trout production from the four State and three Federal hatcheries within the State has climbed 126 percent in the last decade, from 208,000 pounds in 1960 to 470,000 pounds in 1971. Seventy percent of the 1971 poundage was rainbow trout. Trout were released along 887 miles of stream and in 30 impoundments during the year.

Warm-water rivers and waterways. Although sunfishes are the most numerous and widely distributed warm-water game fish, warm-water anglers prefer to fish for small mouth and largemouth bass, walleyes, and catfish (W. Va. Dep. Natural Resources 1973). In 1970, anglers spent 1.6 million angler-days fishing for bass and harvested 2.9 million legal bass. Smallmouth bass especially are recognized as a prized trophy fish and an excellent food fish. Channel catfish, which may attain 15 pounds and 35 inches in major rivers, are an important warm-water sports fish. Nearly 715,000 catfish were harvested in 1970. Other species, such as muskellunge and northern pike, have been introduced from time to time but are still not widely distributed.

In addition to being a game fish, the channel catfish has commercial value. Investigations were first initiated in 1966 to determine the feasibility of opening the Ohio River to commercial fishing. Results showed that the river contained an adequate catfish population to support a commercial fishery, but tests rated the fish low in both taste and odor. Nevertheless, in 1969, two commercial licenses were sold and 3,250 pounds of fish were harvested. Seventy-five percent of the harvest were channel catfish. Eight licenses were issued and 13,970 pounds of fish were harvested in 1970, 83 percent was channel catfish. Commercial fishing was suspended in August 1970 when inspectors found unsafe levels of mercury in freshly harvested fish.

Present warm-water management efforts are keyed to the protection and maintenance of habitat quality along the 6,870 miles of warm-water rivers and streams that now contain fish populations, restoration of warm-water habitat which is too polluted to support game fish, and the reintroduction of game fish into rehabilitated waterways.

Reservoirs and small impoundments. Of the 220 square miles of surface water area in West Virginia, 53 are in impoundments. The Department of Natural Resources manages 106 ponds that contain nearly 15,000 acres of water surface. All of these ponds are open to the public for fishing and contain populations of largemouth bass and bluegills. Many ponds have been stocked with trout and catfish.

Eight large reservoirs, containing over 12,000 acres of water surface, have been constructed by the Corps of Engineers and several local power companies for flood control and power generating purposes. These reservoirs are open for public fishing and contain generally good populations of bass, panfish, and catfish, supplemented by stockings of walleye, muskie, and northern pike. Acid mine drainage is a major fish management problem. Currently, fishery biologists estimate that over a third of the total water surface area of these reservoirs is grossly polluted. (W. Va. Dep. Natural Resources 1973)

Most of the impoundments that have been constructed on private lands are farm ponds either assisted by the Soil Conservation Service or constructed under Public Laws 566 or 534 for soil conservation purposes. Soil Conservation Service records show that 19,822 farm ponds have been constructed with a total surface area of 5,937 acres. A total of 117 P. L. 566 and P. L. 534 impoundments containing some 1,014 acres have been constructed on private lands.

The supply of game fish in impoundments is limited by the area and productivity of the habitat and the ability of the fish population to grow and reproduce under different levels of water quality. The construction of new impoundments usually adds to the supply of desirable fish habitat, especially in the first few years after construction; dredging, siltation, and pollution remove the affected habitat from a productive status.

Habitat requirements and some of the management strategies that may improve the local habitat of some of the important game fish are listed:

Fish species	Habitat requirements and special problems	Positive management strategies
Trout	Requires water temperatures of less than 70° F. and dissolved oxygen of at least 5 ppm. High mineralization has limited reproduction and pollution has destroyed natural habitat.	Rehabilitation of coldwater streams.
Channel catfish	Flourishes in large, deep, low-gradient rivers with clean bottoms of sand, gravel, or boulders. Industrial pollution and high population densities are detrimental to survival and growth.	Stock large man-made impoundments. Encourage commercial harvesting in high population streams.
Muskellunge	Prefers slow flowing, low-gradient streams with long, deep pools that contain submerged brush or logs. These streams range in pH from 6.5 to 7.5, have total alkalinity of 20 to 50 ppm, and hardness of 15 to 75 ppm. Major impoundments and high streamflows destroy habitat and adversely affect reproduction.	Stocking program to expand limited range in West Virginia.
Walleye	Requires large, swift-flowing, clear rivers or deep, clear lakes with gravel, rock, or hard clay bottoms. Siltation of hard bottoms and increased turbidity destroys natural habitat.	Rehabilitation of polluted rivers that otherwise are good habitat. Stock large man-made impoundments.
Largemouth bass	Prefers warm, shallow, mud-bottomed lakes with lush aquatic vegetation and over-hanging, brush-covered banks.	Maintain and improve existing population by encouraging large harvests and introducing forage species.
Smallmouth bass	Prefers cool flowing streams and large, clear lakes with pH range of 6.7 to 8.5. Acid mine drainage has destroyed the fishery in many West Virginia streams.	Rehabilitation of polluted streams and reintroduction of bass.

References providing the major sources of information in this "Fish" summary are as follows:

1. Adkins, James R., et. al. 1976. Comprehensive Survey of the New River Basin (Volume I - Inventory).
2. Hocutt, C. H., et. al. 1979. Fishes of the Gauley River, West Virginia.
3. Northeastern Forest Experiment Station. 1978. The Forest Resources of West Virginia.
4. Stauffer, Jay R., et. al. 1980. Aquatic Biological Survey of the New River, Virginia and West Virginia.
5. US Department of Interior. 1980. Endangered and Threatened Wildlife and Plants -Native to the United States.

INVERTEBRATES

Several people have collected invertebrates in the New River drainage. Newcombe in 1929 recognized 6 species of crayfish from the New River drainage in West Virginia. Hobbs (1969) considered the distribution of the crayfish genus Cambarus in the southern Appalachians. Lawton (1979) described nine species of crayfish distributed in the New River drainage. A tenth species Orconectes erismophorous is thought to be a possible species in Summers County. The following species are widespread in West Virginia and are known to occur in the New River Gorge area:

Cambarus dubius
Cambarus robustus
Cambarus sciotensis
Cambarus bartonii
Orconectes obscurus
Orconectes sanbornii
Orconectes spinosus

Orconectes virilis occurred in Bluestone Lake and was the first known station in West Virginia. Cambarus chasmodactylus has been verified in the Greenbrier River, Bluestone River and Summers County. C. chasmodactylus is the most likely candidate to be placed on the future list of West Virginia's rare and endangered species.

Stauffer, et. al. (1980) collected the following species from New River in the summer of 1979:

Cambarus bartonii
Cambarus sciotensis
Cambarus robustus
Orconectes obscurus
Orconectes spinosus
Orconectes virilis

Cambarus sciotensis and Orconectes spinosus were the most common species of the respective genera in New River. Orconectes virilis

was first collected by Lawton from Bluestone Lake in 1978 but had begun to radiate throughout the New River system by 1979. Stauffer, et. al. (1980) collected O. virilis in Monroe, Raleigh and Fayette Counties.

Crayfish species had very limited populations below Sandstone Falls, especially Cambarus bartonii and Orconectes spinosus. O. spinosus was found in only two tributaries to the New River below Sandstone Falls. C. bartonii was found in only two locations below the Falls, but was widely distributed above.

Stauffer, et. al. (1980) collected 6 species of freshwater clams from the New River in the summer of 1974. These 6 species are as follows: Tritogonia verrucosa
Cyclonaias tuberculata
Elliptio dilatata
Actiononaias carinata carinata
Lampsilus ovata ventricosa
Corbicula manilensis

Cyclonaias tuberculata was the most abundant unionid species present. Ortmann collected 4 species of clams in the New River in 1913. One, Lasmigona subviridis, was not collected by Stauffer, et. al. (1980). Three species, Actinonaias carinata Lampsilus ovata ventricosa and Corbicula manilensis, were collected in addition to those reported by Ortmann in 1913. All three species were also collected in the Kanawha River below Kanawha Falls by Morris and Taylor (1978). The introduced Asian clam, Corbicula manilensis, is well established throughout the study area of New River Gorge.

The US Fish and Wildlife Service lists no species of West Virginia crayfish as rare and endangered. The following three clams are listed as rare and endangered:

Pearly mussel, pale lilliput	Toxolasma cylindrella
Pearly mussel, pink mucket	Lampsilus orbiculata
Pearly mussel, tuberculed-blossom	Epioblasma torulosa

These three mussels have been collected from the Kanawha River below Kanawha Falls, but have not been found in the New River Gorge.

References providing the major portion of the information included in this summary were as follows:

1. Hobbs, H. H., Jr. 1969. On the Distribution and Phylogeny of the Crayfish Genus Cambarus.

2. Lawton, Steven M. 1979. A Taxonomic and Distributional Study of the Crayfishes (Decapoda: Cambaridae) of West Virginia with Diagnostic Keys to Species of the Genera Cambarus and Orconectes.

3. Morris, John S. and Ralph W. Taylor. 1978. A Survey of the Freshwater Mussels (Bivalva: Unionidae) of the Kanawha River of West Virginia.

4. Stauffer, Jay R., et. al. 1980. Aquatic Biological Survey of the New River, Virginia and West Virginia.

5. US Department of Interior. 1980. Endangered and Threatened Wildlife and Plants - Native to the United States.

HERPTILES

There have been no systematic or comprehensive studies of the amphibians or herptiles of the New River Gorge.

Lightburn (1976) made an intensive search during the two-week Brooks Bird Club foray of 1975. He concentrated on the New River Gorge in Raleigh County and located 26 species of amphibians and herptiles. His list included the northern cricket frog which is considered to be rare in West Virginia.

Bayless (1979) reports 60 new county records in southern West Virginia from 1966 through 1974 and an additional 12 county records collected since 1974. Several of these records are from Fayette, Raleigh and Summers Counties but "most of the records are within the known ranges for the species". Bayless (1972) reported a viable population of the Florida cooter, Chrysemys floridana, for Bluestone Lake which is adjacent to the New River Gorge National River.

Green (1978) completed the most comprehensive compilation of amphibians and herptiles in West Virginia. He lists 80 species of amphibians and herptiles for the state and includes a figure indicating the occurrence by counties for the various species. Specific locations are not stated but any which occurred in New River Gorge could be confirmed by the collected specimens which are kept in the West Virginia Biological Survey collections, currently housed at Marshall University in Huntington, WV.

Rare and endangered fauna for West Virginia are in the final stages of being published. There are no amphibians or herptiles from West Virginia on the federal list as of October, 1980.

References providing the basis for this summary are listed below:

Bayless, Laurence E. 1972. A New Turtle Record, Chrysemys floridana, for West Virginia.

Bayless, Laurence E. 1979. New Herpetological Records from Southern West Virginia.

Green, N. B. 1978. Amphibians and Reptiles in West Virginia.

Lightburn, Robert C. 1976. Herptiles of Raleigh County, West Virginia.

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This annotated bibliography is listed on cards in an alphabetical order by the author's last name. A cross referenced index listing author, year published, and title for each literature source is organized by subject headings using specific key words which are listed below.

KEY WORDS;

Animals	- Birds	-Herptiles
	- Fish	-Mammals
	- Ecology & Natural History	-Rare
	- Invertebrates	
Geology	- Economic	-Paleontology
	- Stratigraphy & Structure	-Soils
	- Historical	-Resource Inventory & Water Resources
Botany	- Ecology	-Rare
	- Distribution, Lists & Taxonomy	-Natural History
Forest	- Cover Types & Distribution	-Ecosystems
	- Economics	-Taxonomy & Tree Lists

Non Vascular Plants

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US Department of Interior. 1979. Preliminary Habitat Evaluation Report of the Proposed Bluestone Pumped Storage Project, Location "G" of the Kanawha Study.

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Grafton, William N. and Claude Mc Graw. 1976. The Vascular Flora of New River Gorge, West Virginia.

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Ammons, Nelle. 1934. Preliminary List of West Virginia Mosses.

Ammons, Nelle. 1940. A Manual of Liverworts of West Virginia.

Gilbert, Frank A. 1929. A Preliminary Report of the Slime Molds of West Virginia.

Mc Neil, Ellis Meade. 1948. A Contribution to the Knowledge of West Virginia Algae.

Millspaugh, C. F. and David White. 1913. Part I- The Living Flora of West Virginia and Part II- Fossil Flora of West Virginia.

Sheldon, John L. 1939. The Lichens of West Virginia.

Adkins, James R., et. al. 1976. Comprehensive Survey of the New River Basin (Volume I-Inventory). WV Department of Natural Resources-Division of Water Resources. 207 pp.
Libraries and Agency.

Contains an extensive inventory of the physical characteristics and features of New River and immediate tributaries in West Virginia. Various chapters deal with a description of the basin, general economics, climate, geology, mineral resources, land resource, land uses and management, recreation, surface water, water quality, ground water, water supply, and water resources development. Specific areas of general use for the New River Gorge National River planning deal with coal, natural gas, land use, hunting, fishing, soil series, and land capability.

Ammons, Nelle. 1940. A Manual of Liverworts of West Virginia. The American Midland Naturalist Vol. 23:1. pp. 3-164.
Libraries

Lists 16 species for Fayette County, 0 for Raleigh and Summers Counties. None of the species listed are rare.

Ammons, Nelle. 1934. Preliminary List of the West Virginia Mosses. Bryologist Vol. 37. pp. 65-74.
Organization and Libraries

This is an up to date (1934) listing of mosses, their habitats and locations for West Virginia.

Arkle, Thomas, Jr. and Richard Hunter. 1957. Sandstones of West Virginia. WV Geological and Economic Survey. Morgantown, WV. 58 pp.
Libraries, Agency and For Sale

Gives a breakdown of the sandstones into areas of West Virginia based on composition and other structural characteristics. Provides basic economic information on the use of high silica sandstones which do occur in New River. Discusses the Pottsville and Mauch Chunk Series which occur in New River and gives their distribution.

Arkle, Thomas, Jr., et. al. 1979. The Mississippian and Pennsylvanian (Carboniferous) Systems in the United States-West Virginia and Maryland. United States Government Printing Office. Washington, D.C.

For Sale

This report is a descriptive review of the Mississippian and Pennsylvanian strata which occur in West Virginia (including New River). The descriptions are fairly technical and general. There is a short summary on the paleontology of each system. Figures and maps with important information are as follows:

1. Geologic map of the late Paleozoic.
2. Structural map of the late Paleozoic.
3. Late Paleozoic mineral resources of West Virginia.
4. Outcrop of Mississippian in West Virginia.

(over)

5. Cross section of Mississippian along the outcrop belt.
6. Geologic cross section from the Ohio River to Princeton.
7. Pennsylvanian system selective classification.

Good overall and comparative view of the strata of New River Gorge to surrounding areas.

Barlow, James A. 1974. Coal and Coal Mining in West Virginia. WV Geological and Economic Survey. Coal-Geology Bulletin No. 2. Morgantown, WV. 63 pp. Libraries, Agency and For Sale.

This text is a good general report on all aspects of coal mining. It is written for the general public but could be useful to a coal producer. Very general information could be gathered about past and present coal mining activities in the New River area. Other information includes the qualities of coal and descriptions of the various methods of mining coal. Also included is a glossary of terminology dealing with mining.

Bailey, L Wayne. 1951. Wild Turkey Mgt. in West Virginia. The Conservation Commission of West Virginia. Charleston, WV. 49 pp. Libraries.

Wild Turkey range at the time of the study included Fayette, Raleigh and northern Summers Counties. Fayette County was listed as having potential turkey habitat. Information included:

1. Life Histories
2. Environmental factors and influences
3. Food preferences
4. Diseases, parasites, and predation
5. Preferred habitat
6. Mating habits

Bayless, Lawrence E. 1972. A New Turtle Record-Chrysemys floridana, for West Virginia. Journal of Herpetology Vol. 6:1. pp. 39-41. Libraries

The first known occurence of Chrysemys floridana was reported from the Bluestone Resevoir, in Summers County. Geographically, the closest populations were from the Virginia Piedmont. These species found are speculated to have migrated via the New River or were introduced by man.

Bayless, Lawrence E. 1979. New Herpetological Records from Southern West Virginia. Proceedings of the West Virginia Academy of Science Vol. 51:2 pp. 65-67 Libraries and Organizations

Collections in southern West Virginia since 1974 have yielded 12 new county records (includes 2 from Fayette and 1 from Raleigh).

Bell, Ralph K. 1976. The 1975 Foray Bird List. The Redstart Vol. 43:1. pp. 11-21. Libraries and Organization

Lists 114 birds identified in all parts of Raleigh County and northwestern Summers County. Locations of the rare birds given.

Boivin, Bernard. 1947. Thalictrum in West Virginia. Castanea Vol. 12. Page 116. Libraries and Organization

Lists Thalictrum clavatum as growing in Nuttalburg and Thalictrum steeleanum in Raleigh County at Terry in a large rockpile on the mountainside.

Boone, Weldon. 1934. Native Trees of Summers County. 22 pp.
Rare

Includes a description and habitat range of the native trees of Summers County, with locations of the most uncommon species. The paper contains a simplified key to native and introduced trees for use by high school students. This key could be revised and updated to provide a useful interpretive guide for the general public to study trees of the New River Gorge area.

Brooks, A.B. 1911. Forestry and Wood Industries West Virginia Geological Survey Vol. 5. Mgtn., WV. Libraries and Rare 481 pp.

Contains a complete but general description of the tree species and forest composition throughout the state. Very scattered information can be gathered from the text on the former forest compositions of Fayette, Raleigh and Summers Counties. However, there is a lack of specific information on the New River Gorge. The New River is mentioned frequently as a major stream along with other rivers for which better descriptions of the forests are given. It can be deduced that the virgin forests in the New River had mostly been cutover by 1911. The completion of the C & O Railroad through the Gorge in 1872 was a major factor affecting timber harvesting.

Brooks Bird Club. 1954. Area Survey of 1954 Foray - The Ornithological Results of the 1954 Foray. The Redstart. Vol. XXI - #4. page 67.
Libraries and Organization

Very general description of the topography and forest cover types is given. The report covers an 8 day study and systemactic survey of the breeding birds present in a 15 mile radius from the camp Beckwith near Fayetteville. This study included the gorge area below Fayetteville. One hundred and three species of birds were found to be present in the study area, including 21 different kinds of Warblers, and a new station for Swainson's Warbler. A listing of species and locations is given.

Brooks Bird Club. 1954. Breeding records established for the 1954 Foray. The Redstart. Vol. XXII, #1. pp. 3-12
Libraries and Organization

This report further qualifies the date recorded in the Sept. 54 issue on the 1954 Foray.

This report concluded that 177 nests of 51 species were found with 29 young out of the nest recorded giving a total of 55 species that were nesting in the area. A chart of the nesting species is given with respective information on the number of new nests, eggs, young and young out for each species. Also, habitat and location of nest sites is given.

Brooks Bird Club. 1976. The 1975 Foray. The Redstart. Vol. 43:1 53 pp.
Libraries and Organization

Raleigh County was the subject of a two week intensive foray of the Brooks Bird Club. The study includes, a systematic survey for vegetation types and breeding birds. None of the study plots were actually in the gorge. However, the study week also included random field trips which did include the gorge area. Lists of existing birds, mammals, herbs, trees, shrubs and invertebrates would probably be applicable to New River. The locations of the birds cited are given in general.

Brooks, Earl L. 1916. The Food of West Virginia Birds. West Virginia Dept. of Agriculture. Charleston, WV. 74 pp.
Rare

Describes the major families of West Virginia birds and their eating habits, what they eat, natural history, and relative economic importance. Discusses eating habits relative to fruits, grains, vegetables, weeds, seeds, and insects. Includes a discussion on carnivorous and scavenger birds. Conclusions are based on the writers observations and studies over a period of many years.

Brooks, Maurice. 1971. The Southern Appalachians. VPI & SU Monograph-The Distributional History of the Biota of the Southern Appalachians, Part III - Vertebrates. Blacksburg, VA. (Edited by Perry C. Holt). pp. 1-9.
Libraries

Cold blooded vertebrates which have recognizeable Appalachian races and species include, minnows, darters (particularly in the New River, and its tributaries), and among the reptiles, a few snakes

Burch, J. B. 1969. Land Mollusks of the Southern Appalachians. Virginia Polytechnic Institute Monograph I-The Distributional History of the Biota of the Southern Appalachians-Part I: Invertebrates (Edited by Perry C. Holt). Blacksburg, VA. pp. 247-264.
Libraries.

This paper deals with land snails and their distribution. While listing numerous endemics, no mention of specific locations are given.

Campbell, Marius R. and Walter C. Mendenhall. 1896. Geologic Section Along the New and Kanawha Rivers in West Virginia. US Geological Survey. Washington, D.C. 30 pp.
Rare

This is a chart showing a geologic section along the C & O Railroad from Hinton to Charleston. It includes a description of the rocks and subsequent coal seams within each formation. A total of 8 formations are discussed.
Eleven photographs of geologic formations are included.

Cardwell, Dudley H. 1975. Geologic History of West Virginia. West Virginia Geological and Economic Survey. 64 pp.
Agency and For Sale

This publication includes 21 figures and 2 tables of which all are explicit and well detailed on the subject of WV Geology.

The text covers in a fairly detailed account the geologic history of WV from almost the beginning of geologic time to the present. The areas covered from the text included, Stratigraphy, paleontology, geologic structure and evolution of the present land features. Some discussion is also given on the coal seams.

Cherry, D.S., et. al. 1980. Dynamics and Control of the Asiatic Clam in the New River, Virginia, USA. Virginia Polytechnic Institute and State University Water Resources Research Center Bulletin. Blacksburg, VA. 72 pp.
Libraries and Organization

This introduced clam is a threat to the native mollusks of the New River. This article includes life history information should management plans be instituted to reduce its numbers.

Chisholm, James and Prentis M. Frye. 1976. Records of Wells, Springs, Chemical Analyses of Water, Biological Analyses of Water, and Standard Streamflow Data Summaries from the Upper New River Basin in West Virginia. 80 pp.
Libraries and Agency

This report involved only that section of the New River Basin from the Virginia-West Virginia border to Hinton, WV. It includes tables of data on water resources and water quality data. Ten tables give information on the lithic characteristics of the bedrock, chemical analyses and biological analyses of numerous springs, wells and streams throughout the area.

Clarkson, Roy B. 1959. The West Virginia Spiraea. Castanea Vol. 24. pp. 143-146.
Libraries and Organization

Spiraea virginiana was found in Fayette County at a location one mile upstream from Cotton Hill on June 8, 1954 by Hicks and Bartley.

Clarkson, Roy B. 1961. Fraser's Sedge, Cymophyllus fraserii (Andrews) Mackenzie. Castanea Vol. 26. pp. 129-136.
Libraries and Organizations

Three locations were listed for New River Gorge in Fayette County as follows:

1. Rocky gorge, Boone, May 21, 1926. Shear
2. In the canyon of New River near Nuttalburg, April 21, 1892. Nuttall.
3. Deep woods near Nuttalburg, July 23, 1932-Wherry.

Core, Earl L. 1936. The Botanical Explorations of West Virginia. Proceedings of the West Virginia Academy of Science Vol. 10. pp. 46-60
Libraries and Organization

Contains a list of individuals who made botanical explorations in West Virginia. Herbariums where collected specimens are deposited are named. Only five early explorers collected in the New River Gorge.

Core, Earl L. 1937. The genus Carex in West Virginia. Proceedings of the West Virginia Academy of Science. Vol. 11. page 29.
Libraries and Organization

A description of the 63 species and site locations that were known for West Virginia. Many of these were located in the New River Gorge near Nuttalburg.

Core, Earl L., et. al. 1944. West Virginia Grasses. West Virginia University Agricultural Experiment Station Bulletin 313. 96 pp.
Libraries and Organization

A list of all grasses known from West Virginia along with ranges and illustrated sketches.

Core, Earl L. 1950. Notes on the Plant Geography of West Virginia. Castanea Vol. 15. pp. 61-70.
Libraries and Organization

General information on climate, botanical exploration, plant communities, forest types, unique plant habitats, flowers, succession and plant migration. "Other eastern species, as fringetree, silverbell tree, and Canby's Mountain -lover may have entered the state through.. ... the New-Kanawha valley."

Core, Earl L. 1952. Lawrence William Nuttall. Castanea Vol. 17. pp. 157-164
Libraries and Organization

Biography of the life and works of this Botanist of the New River. Nuttall collected nearly 1000 flowering plants and hundreds of fungi, which are deposited in the West Virginia University Herbarium.

Core, Earl L. 1966. Vegetation of West Virginia. McClain Printing Company. Parsons, WV. 217 pp.
For Sale

This book includes several chapters describing vegetation which occurs in New River Gorge such as cover types, xeric, mesic and hydric forests, cliff vegetation, aquatic vegetation, etc. Other areas deal with succession and plant migration routes.

Core, Earl L. and Roland Guthrie. 1968. Common Forest Trees of West Virginia. WV Department of Natural Resources. Charleston, WV. 120 pp.
For Sale

Booklet of the common forest trees of WV designed for the general public. Includes natural history information such as distribution, habitat, and the identifying characteristics of bark, wood, leaves, fruit and flowers.

Craigo, Robert. 1976. The New River Company- 70 Years of West Virginia Coal History. New River Company. Mt. Hope, WV. 108 pp.
Organization

Contains a history of a large coal company called "The New River Co." from its beginning in 1906 to the present. Chronological description of the lands and mines operated by this company. Contains the production in tons of coal and profits of the mines. A map shows the relative locations of the mines and lands associated with each mine. Charts list the annual production by mine from 1905-1976. Many cultural facts about the development of the mines and the mining towns are included.

Most of the mines were located between Beckley and Fayetteville.

Degarmo, W.R. and John Gill. 1958. West Virginia Whitetails. The Conservation Commission of WV. Charleston, WV. 87 pp.
Agency

Intensive study on the life habits, ecology life history, foods, populations, distribution, and management of deer. Extensive study of deer, in WV, but no specific references to the New River area.

Dyar, Robert F. 1957. The Bluestone Group, Princeton Conglomerate and Hinton Group-Mauch Chunk Series in Southeastern West Virginia. Masters Thesis at West Virginia University. Morgantown, WV. 122 pp.
Libary at WVU

A detailed measurement of nine stratigraphic sections along the Mauch Chunk outcrop belt in Mercer, Summers and Greenbrier Counties. In addition to the measured sections, four subsurface sections from Fayette and Raleigh Counties were selected from the files and published works of the WV Geological Survey. The surface and subsurface sections were combined into three profiles from which a correlation of the various formations of the interval under study were determined. A very technical publication.

Englund, Kenneth J. 1968. Availability of Low-Sulfur Coal in Raleigh County, West Virginia. US Geological Survey. Washington, D.C. 23 pp.
For Sale

Published analyses of 206 samples from 17 of the 19 principal coal beds in Raleigh County indicate that 12 beds average less than 1.0 percent in sulfur and the remaining 5 beds average less than 2.0 percent in sulfur. Text includes an excellent description of the various stratigraphic formations found in Raleigh County.

Ferguson, Roland. 1964. The Timber Resources of West Virginia. Northeastern Forest Experiment Station. Upper Darby, PA. 123 pp.
Libraries and Agency

This is an update of similar but less extensive surveys completed in 1949 and 1953. This data has been superseded by a more recent survey in 1978.

Fernow, Bernhard E. 1888. The Great Timber Belt. State Tribune. Charleston, WV. 21 pp.
Rare

The greatest extent of uncut hardwoods in the eastern United States was within 150 mile radius of Charleston, WV. The counties of Fayette, Raleigh and Summers were probably 80% virgin. The dominant trees of this vast forest were oaks and tulip poplar. Comments on New River are about the rough terrain and inability to drive logs down the river. These factors are mentioned as barriers to timbering.

Fisher, Howell. 1868. Description of Great Falls of New River and Coal Lands Adjacent. Pottsville, PA. 11 pp.
Rare

Analyzes the possibility of water power at present day Sandstone Falls. Presents the basic feasibility study of iron manufacture in New River Gorge based on the local existence of high quality coal, iron and limestone.

Fortney, Ronald H., et. al. 1978. Rare and Endangered Species of West Virginia: A Preliminary Report-Volume 1: Vascular Plants. West Virginia Heritage Trust Program of the Department of Natural Resources. Charleston, WV. 76 pp.
Agency and For Sale

Text includes a general description of the physiographic provinces and plant distribution of West Virginia. Also includes a specific description of special habitats in the State such as, "rocky riverbanks" and "sandstone cliffs and ledges" which are found in the New River Gorge. Lists 12 federally threatened, 7 possibly extirpated, 11 disjunct, 49 restricted, 129 peripheral, and 152 status undetermined plants. The listing includes names, frequency and counties in which the plants are located.

Fridley, Harry. 1950. The Geomorphic History of the New-Kanawha River System. WV Geological and Economic Survey. (Report #7). Morgantown, WV. 12 pp.
Libraries and Agency

Explains the history of the previous flow of the New River before the ice age. The change in flow occurred many miles below the Gorge at Nitro, WV. on the Kanawha River. This paper is a good explicit description of the geologic history of the New River.
Photo: New River Gorge from Hawks Nest.

George, Raymond C. and Robert I. Cantor. 1973. Water Quality Assessment for the Kanawha River Basin (North Carolina, Virginia, West Virginia). Environmental Protection Agency. Wheeling, WV. 34 pp.
Libraries and Agency

A discussion on the water quality of the Kanawha River Basin is given. The subjects covered include surface drainage, water pollution, sewage, recreational facilities and fishing. The streams covered include most of the tributaries of the Kanawha River, including the New River.

Gilbert, Frank A. 1929. A Preliminary Report of the Slime Molds of West Virginia. Proceedings of the West Virginia Academy of Science Vol. 3, pp. 71-73.
Libraries and Organization

Includes a summary of 68 species of slime molds found in WV. Lycogala conicum Pers. from Hinton is the only rare form of slime mold in the New River Gorge area.

Gillespie, W. H. and J. A. Clendening. 1964. Bibliography and Index to West Virginia Geology, Archeology and Pedology. West Virginia University. Morgantown, WV. 241 pp.
Libraries and For Sale.

This is a compilation of over 3100 references published between 1741 and 1962. Lists all articles and books dealing with every phase of West Virginia geology, mineral resources, soils, archeology, geography, etc.

Gillespie, W. H. and I. S. Latimer, Jr. 1961. History and Bibliography of West Virginia Paleobotany. WV Geological and Economic Survey Educational Series ED-4. Morgantown, WV. 26 pp.
Libraries and Agency.

Contains a brief history of the study of plant fossils in West Virginia including an extensive bibliography.

Gillespie, William H. and Hermann W. Pfefferkorn. 1976. Plant Fossils in Early & Middle Parts of the Proposed Pennsylvanian System Stratotype in West Virginia. (Reprint from G.S.A. field trip guidebook No. 3, "Carboniferous Stratigraphy of Southwestern Virginia and Southern West Virginia". joint northeast and southeast section meeting, Arlington, Virginia, March, 1976). 7 pp.
Organization.

Plant fossils which occur in the Pennsylvanian system strata are mapped as they occurred through given geologic time spans (stratigraphic ranges).

Gillespie, William H., et. al. 1978. Plant Fossils of West Virginia. West Virginia Geological and Economic Survey. Morgantown, WV. 172 pp.
Agency and For Sale

Contains a discussion and introduction to paleobotanical studies. Gives a chronological discussion of each geologic period and the vegetation types of each as they have been reconstructed from plant fossils. Includes pictures and descriptions of all fossils and their old and new names. New River strata have numerous fossils and this text would be essential for interpreters.

Gluck, Norris. 1976. Breeding Birds Records for 1975 Foray. The Redstart Vol. 43:1 pp. 47-49.
Libraries and Organization

A list of 35 bird species and 75 nests. Information includes number of young birds, height of nest, altitude and location.

Gluck, Norris and C. O. Handley, Sr. 1973. Birds of Upper Kanawha Valley-1872-1972. The Redstart Vol. 40:2. pp
Libraries and Organization

In 1872 a Harvard University student spent two months at Coalburg and made a list of 86 birds and their distribution frequency. A chart of these same species with relative frequencies was determined at the same location in 1972, for comparison.

Goodell, Scott K. 1978. Waterway Preservation: The Wild and Scenic Rivers Act of 1968. Boston College Environmental Affairs Law Review Technical Report Vol. 7:1. pp. 43-82.
Libraries

The Wild and Scenic Rivers Act of 1968 was created to prevent the continued decay of free-flowing rivers. The federal wild and scenic rivers system, which was formed to implement the act and its impact on waterway preservation during the last 10 years are reviewed. Legislative mechanics and the problems of delays and escalating costs are discussed. Various state systems, in particular, the devices to the federal system.

Grafton, William N. and Claude McGraw. 1976. The Vascular Flora of New River Gorge, West Virginia. 19 pp.
Libraries and Rare.

This study includes discussion of the geologic formations, plant associations and rare plants of the Gorge from Bluestone River to Gauley River at Gauley Bridge. This study located and identified 122 families, 476 genera and 1064 species of plants. Particular discussions involve plants that have migrated into the gorge, plants normally found at higher elevations and plants that were state records for West Virginia. Locations of the more unusual plants can be obtained from the authors.

Grafton, William N. and Zettie Stewart. 1976. Herbaceous Flowering Plants for the 1975 Foray. The Redstart Vol. 43:1. pp. 30-47.
Libraries and Organization

A list of herbaceous plants which includes names and locations of county records for Raleigh (23), Fayette (6), and summers (6), Counties.

Grafton, William N., et. al. 1976. Trees, Shrubs and Woody Vines for the 1975 Foray. The Redstart Vol. 43:1. pp.23-27.
Libraries and Organization

A complete list by scientific and common names of the woody flora of Raleigh County and the northwestern section of Summers County.

Green, N. Bayard. 1969. The Occurrence and Distribution of Turtles in West Virginia. Proceedings of the West Virginia Academy of Science Vol. 41, Page 1.
Libraries and Organization

Thirteen species of turtles were recorded as occuring in West Virginia. Three species-(snapping, stinkpot, and eastern box turtle), have a statewide distribution. Two species-(midland painted and eastern spring softshell), occur west of the Allegheny Front. The remaining eight are distributed in parts of the state not relative to the New River Gorge area.

Green, N. B. 1978. Amphibians and reptiles in West Virginia. Marshall University, Huntington, WV. 48 pp.
Agency and For Sale

A listing of amphibians and reptiles, their distribution, habitat, and frequency in the State.

Hadley, Donald G. 1966. Availability of Low-Sulfur Coal in Fayette County, West Virginia. US Geological Survey. Washington, D.C. 20 pp.
For Sale

Of the total 51 coal beds, 22 were defined as commercial. Of this 22 commercial beds, 17 contain less than 1.0 percent sulfur, and the remainder average less than 2.0 percent sulfur. Descriptions of all stratigraphic formations in the County are given. Estimates are given of the coal mined between 1888 and 1966, as well as the coal reserves remaining.

Harbrick, P.S., et. al. 1975. Distribution Habitat and Food of the Cyprinid Fish Phenacobius teretulus, A New River Endemic. Copeia - pp. 172-176

Haught, O. L. 1964. Coal and Coal Mining in West Virginia. WV Geological and Economic Survey. Morgantown, WV. 38 pp.
Libraries and Agency.
A general discussion of the formation of coal, the description of coal beds in WV, and methods of mining.

Haught, O. L. 1964. Oil and Gas in West Virginia. WV Geological and Economic Survey Educational Series ED-5. Morgantown, WV. 42 pp.
Libraries and Agency.
This is a general discussion of the origin, history and production of oil and gas in West Virginia.

Headlee, A. J. and J. P. Nolting. 1940. Characteristics of Minable Coals of West Virginia. WV Geological and Economic Survey. Morgantown, WV. 272 pp. & 112 figures.
Libraries, Agency and For Sale.
Contains a description of minable coal seams, with figures showing probable minable extent of each seam. Also included is a statistical study and correlation of West Virginia coal analyses. The appendix contains coal analyses and tables showing estimated original tonnages. A map shows the location of commercial coal mines in WV.

Headlee, A. J., et. al. 1955. Characteristics of Minable Coals of West Virginia. WV Geological and Economic Survey. Morgantown, WV. 166 pp & 68 figs.
Libraries, Agency and For Sale.
This text is a continued study from a 1940 publication. Characteristics examined by this report are sulfur content, inorganic elements, structure of bituminous coals and changes in the concentration of inorganic elements during coal utilization. This discussion could be useful to the interpreter wanting to understand the properties that make certain coals more valuable than others. However, the text is fairly technical and may not be applicable for a management plan.

Heck, Edward T. 1937. Correlation and Stratigraphy of the Pottsville Series of Eastern Fayette, Southeastern Nicholas and Western Greenbrier Counties. Masters Thesis at West Virginia University. Morgantown, WV. 68 pp.
Library at WV University

A detailed and explicit study of the New River and Pocahontas groups of the Pottsville Series of southeastern WV. The specific areas under consideration in this study did not include the New River Gorge area, however the detailed descriptions and information about the rock strata covered do include rocks outcroping in the New River Gorge. Very good descriptions are given on the sandstones, coals, shales and the extent of the range of these stratas are given. There are charts showing the thickness and total feet of the components of the Pottsville Series.

Hennen, Ray V., et. al. 1919. Fayette County-Detailed County Report. West Virginia Geological Survey. Morgantown, WV. 1002 pp.
Libraries and Agency.

This book provides the most complete detailed geologic information on all aspects of Fayette County and New River in Fayette County. Information relative to New River includes:

1. A general topographic and physiographic description of Fayette County.
2. Gradient per mile for key points on all major drainages of New River.
3. Overall geologic structure.
4. Detailed geologic sections taken throughout the County, including exposures along New River.
5. Detailed description of each geologic series and strata.

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6. List of all known invertebrate fossils which occur in the Pottsville Series.

Over half of the text deals with the mineral resources and includes the following key subjects:

1. Well records and prospective oil and gas areas.
2. Oil and gas horizons of WV.
3. Statistics of coal production and the minable coal beds.
4. Records of coal test borings.
5. Information on clays, road materials, building stone, sand, water power, and forests.
6. A list of all railroads and their stations.

This book includes several illustrations and pictures depicting geologic features.

Hennen, Ray V., et. al. 1919. Map II of Fayette County General and Economic Geology. WV Geological Survey. Morgantown, WV.
Libraries and Agency

This map is used to depict data and information from the Fayette County "detailed county report". Major coal seams, stratigraphic information, oil and gas wells and coal mines are located on this topographic map of Fayette County.

Hill, Paul, Bill Cremeans, Mary Beth Roush, and Donald Tarter. 1978. State Records for the Family Phryganeidae in West Virginia. Proceedings of the West Virginia Academy of Science. Vol. 50, # 1. Page 24.
Libraries and Organization

Six state records for the cadisfly are noted. Three for Raleigh County and Two for Summers. Some of these species may be found along streams and rivers and could possibly be present in the New River Gorge.

Hobbs, Horton H., Jr. 1969. On the Distribution and Phylogeny of the Crayfish Genus Cambarus. Virginia Polytechnic Institute Monograph I- The Distributional History of the Biota of the Southern Appalachians-Part I: Invertebrates (Edited by Perry C. Holt). Blacksburg, VA. pp. 93-178.
Libraries.

This summary lists six species and two endemic subspecies for the Kanawha River drainage. The 6 species and their ranges are listed below:

Cambarus bartonii-widespread
Cambarus cavatus- New River and Greenbrier River.
Cambarus laevis- Ohio River.
Cambarus robustus- Kanawha and New River.
Cambarus nerterius- Greenbrier River
Cambarus chasmodactylus- Greenbrier & Upper New Rv.

Hocutt, Charles H. 1979. Fishes of the Gauley River, West Virginia. Brimleyana pp. 47-80.
Libraries

List of 50 species collected on Gaualey River in 1976. Summary of this and other verified reports of fishes, the total is now at 58 species for Gauley River. Contains an excellent literature review of the New River which lists rare fish collections and endemics.

Hocutt, C.H. and P.S. Harbrick. 1973. Hybridization between the Darters Percina crassa Roanoka and Percina oxyrhyncha Percidae Etheostomatini, with comments on the Distribution of Percina Crassa Roanoka in the New River. American Midland Naturalist Vol. 90:2. pp. 397-405.
Libraries

Notes on this darter which occurs in New River from Wst Virginia to North Carolina, includes information necessary for its life history.

Hoffman, John. 1962. Water and the Future of West Virginia. WV Department of Natural Resources Division of Water Resources Bulletin No. 1.
Libraries and Organization

Includes general information on overall water resources and the hydrologic cycle of West Virginia is stated.

Holt, Perry C, et. al. (Editors). 1969. The Distributional History of the Biota of the Southern Appalachians. Part I: Invertebrates 295 pp. VPI Monographs, Blacksburg, VA.
Libraries

Includes treatises on geological development, freshwater amphipods, troglobitic asellida, Carabidae beetles, Cambarus crayfishes, Ostracods, Branchiobdellids, diplopods, land snail mollusks, Mecoptera (Insects), drainage evolution and fish. Mostly deals with taxonomy and distribution and life histories.

Hooper, W. P. and S. M. Archer. 1911. The Fayette Journal. Fayette Journal Company, Publishers. Fayetteville, WV. 84 pp.
Rare

Includes a map of Fayette County in 1911 on page 8. Also gives a list of coal seams and coal mines that existed at the time.

Hopkin, Scott D. 1976. A Comparison of Two Benthic Populations Above and Below the Bluestone Dam, Hinton, West Virginia. Proceedings of the West Virginia Academy of Science Vol. 48. 21 pp.
Libraries and Organization

Benthic collections were made monthly from 1974 to 1975 at two stations on New River above and below Bluestone Dam. A greater diversity of organisms was found at the outflow station on the New River.

Janssen, Raymond E. 1973. Earth Science...A Handbook on the Geology of West Virginia. Educational Marketers, Inc. Clarksburg, WV.
Libraries, For Sale

This text is a broad, general treatise on every aspect of the geology of WV. The subjects covered are: Geologic time, geologic history, minerals of the state, rocks of the state, structural aspects of the states geology, fossils, weathering and ersion, glaciers and the ice age.

It also includes an appendix with; geologic timetables, principles of geology, demonstration materials and references to WV geology. This text was produced mainly as a teaching aid or guide for earth science teachers in the public schools.

Jenkins, Robert E., et. al. 1970. Fishes of the Central Appalachian Drainages: Their distribution and Dispersal. The Distributional History of the Biota of the Southern Appalachians. Part IV - Vertebrates. VPI Monographs, Blacksburg, VA.
Libraries pp. 43-117

The range of this paper very much includes the New River Drainage. Though the information given is not compiled on any one section of the river, the data provided could serve as base line information on the New River Gorge area.

The composition, origin, distribution and dispersal of the freshwater fish faunas of the central Appalachian drainages are discussed.

It was mentioned that five endemics occur in the New River System.

Johnston, I.H. 1923. Birds of West Virginia. West Virginia Dept. of Agriculture. Charleston, WV. 138 pp.
Rare

Contains a list of birds with a physical description, nest description, general and WV ranges, and comments. Nothing is specific on New River.

Kellog, Remington. 1937. Annotated List of West Virginia Mammals. Smithsonian Institution. pp. 443-479.
Libraries and Agency.

A list of mammals and collection locations. None of the locations were in New River Gorge.

Kerr, J. A. 1921. Soil Survey of Fayette County, West Virginia. USDA Bureau of Soils. Washington, D.C. 30 pp. and maps.
Rare

Describes the soil types of Fayette County giving structure, texture, slope, subsoil and land capability classifications.

Krebs, C. E. 1927. Fossils, Flora and Fauna in the Coal Measures of the Pottsville Series. Proceedings of the Mine Inspectors' Institute of America (meeting at Charleston, WV.). 8 pp.
Libraries and Rare

This paper provides an incomplete coverage of the fossils in the Pottsville Series. It also provides a well written account on the origin of coal and the extent of the coal beds of West Virginia. Ten figures provide detailed examples of the most common fossil plants found in the New River Gorge area.

Krebs, Charles E. and D. D. Teets, Jr. 1916. Raleigh County and Western Portions of Mercer and Summers Counties- Detailed County Report. WV Geological Survey. Morgantown, WV. 778 pp.
Libraries and Agency

This book provides a complete and comprehensive description of all aspects of geology of the New River in Raleigh and Summers Counties. Topics included in the text are:

1. A general topographic and physiographic description of the area.
2. Gradient per mile on all drainages of New River.
3. Description of the overall geologic structure of the area.
4. Detailed stratigraphic sections throughout Raleigh and Summers Counties. Detailed descriptions of each strata are included.

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5. A list of all known invertebrate fossils from the Pottsville Series.

More than half the text deals with the mineral resources of the area. Some of the key subjects covered are as follows:

1. Oil and gas well records and prospective areas.
2. Statistics of coal production and the minable coal beds.
3. Records of coal test borings.
4. Information on clays, road materials, building stone, sand, water power and forests.
5. A list of railroads and their stations.

Several photographs and illustrations are used to depict the more important geologic features.

Krebs, Charles E. 1916. Map II of Raleigh County showing General and Economic Geology. WV Geological Survey. Morgantown, WV.
Libraries and Agency

This map is used to depict data and information from the Raleigh County "detailed county report". Also included is the western part of Summers County. Major coal seams, stratigraphic information, oil and gas wells and coal mines are located on these topographic maps of the two counties involved.

Laitsch, John T. and Michael Breiding. 1976. Ferns of Raleigh County. The Redstart Vol. 43:1. pp. 29-30.
Libraries and Organization

A list of 46 ferns identified in Raleigh County during a two week foray by the Brooks Bird Club.

Latimer, W. J. 1916. Soil Survey of Raleigh County, West Virginia. USDA Bureau of Soils. Washington, D.C. 34 pp. and maps.
Rare

This is a completed soils survey by the standard of the time. It is outdated but should be of value for a historical look at soils, vegetation and past uses of the land in and near the Gorge.

Lawton, Steven. 1979. A Current List of Crayfishes (Decapoda, Astiidae) of West Virginia. Proceedings of the Academy of Science. Vol. 51:1. pp. 9.
Libraries and Organization

A statewide survey of crayfishes was completed to provide a current list. Collections were from the seven major drainages of the state.

Laycock, George. 1975. New River, Old Problem. Audubon Vol. 77:6. p. 58.
Libraries and Organization

Information on coal mining, white water rafting, aesthetics, and water pollution.

Lightburn, Robert C. 1976. Herptiles of Raleigh County, West Virginia. The Redstart Vol. 43:4 pp. 127-129.
Libraries and Organization

A two-week study of herptiles and amphibians in Raleigh County which included the New River Gorge, was a part of the 1975 Brooks Bird Club Foray. Several species of turtles, snakes, lizards, salamanders, toads, tree toads and true frogs were located and identified.

Lotz, C. W. 1970. Coal Map:Probable Original Minable Extent of the Bituminous Coal Seams of West Virginia. WV Geological and Economic Survey. Morgantown, WV.
Libraries, Agency and For Sale
Includes individual maps of each of the 62 minable coal seams in the state, showing the original minable extent of each seam. Also includes a small scale map of the coal bearing strata of the state and two stratigraphic columns placing all seams in their proper sequence. Coal reserve figures are also determined and stated.

Ludlum, John C. 1951. The Geology of Hawks Nest State Park, West Virginia. WV Geological and Economic Survey. Morgantown, WV. 25 pp.
Libraries, Agency and For Sale

Contains a general discussion of the geology, history, origin and geologic development of the Hawks Nest State Park area.
Five photos of the Hawks Nest area are included.

Mc Colloch, Samuel W. 1957. The Bluefield Group-Mauch Chunk Series in Southeastern West Virginia. Masters Thesis at West Virginia University. Morgantown, WV. 131 pp.
Library at WV University

A discussion of the stratigraphy of the Coney interval of red, hackley shale with some green zones which occurs along the Chessie railroad and Coney Island just southeast of Hinton. Also contains a sparse listing of fossil fauna consisting of species of Myalina and other pelecypods. The Coney interval in the Keeneys Knob stratigraphic section is 70.6 feet thick with interbedded red sandstones and shales with a calcareous zone at its top. Fossils in the Keeneys Knob section were Aviculipecten sp. and Pelecypoda sp. An unusual fossil in the Coney shale was Myalina CF. M. illinoisensis.

McGraw, Claude and William N. Grafton. 1973. The Vascular Flora of New River Gorge-Manns Creek-Fayette County-West Virginia. (Unpublished Study). 53 pp.
Rare

A listing of vascular plants and their frequencies. The Manns Creek watershed includes Babcock State Park and the Sewell area along New River. Special mention is made of New River and the C&O railroad as migration routes for plants. Plants of special habitats (Sewell town site, rocky ravines of Manns Creek, etc.) and rare plants are listed.

McKeever, Sturgis. 1954. Ecology and Distribution of the Mammals of West Virginia. North Carolina State College-Raleigh (Doctoral Dissertation). 335 pp.
Rare

A lengthy discussion of more than 60 mammals which occur in WV. Includes an introduction to the vegetational, climatological, ecological and historical factors determining the presence of these species. The most useful and only complete work available for compiling a list of New River Mammals. Available information on each species includes:

1. Distribution map and locations where specimens were collected
2. Specific habitat requirements and localities
3. Natural histories
   General conclusions of forest succession

trends as they affect mammals are included. Extensive discussions on the present knowledge and theories in relation to animal ecology. Mentions New River as a migration route for species from the south into WV.

Includes a discussion of Pleistocene fossils which have been found in WV.

McNeill, Ellis Meade. 1948. A Contribution to the Knowledge of West Virginia Algae. Castanea Vol. 13. pp. 1-53.
Libraries and Organization

Lists 321 species, varieties and forms but none were from the New River specifically. This article summarizes a doctoral dissertation completed at Duke University.

Madson, John. 1961. The White-Tailed Deer. Conservation Department of Winchester-Western Division of Olin Mathieson Chemical Corp. East Alton, IL 108 pp.
Organization and For Sale

Text includes non-technical information on the life history, management and hunting aspects of the deer.

Madson, John. 1964. Gray and Fox Squirrels. Conservation Department of Winchester-Western Division of Olin Mathieson Chemical Corp. East Alton, IL 112 pp.
Organization and For Sale

Discusses the life history, management, and hunting aspects of squirrels in a non-technical manner.

Madson, John. 1969. Ruffed Grouse. Conservation Department of Winchester-Western Division of Olin Mathieson Chemical Corp. East Alton, IL 103 pp.
Organization and For Sale

Text includes a discussion of non-technical information on the life history, management, hunting aspects, and population cycles of the grouse.

Martin, Robert F. 1939. The Rushes of West Virginia. Castanea Vol. 4. pp. 40-49.
Libraries and Organization

Rare rushes mentioned were Juncus dudleyi at Nuttalburg and Luzula carolinae Var. saltuensis at K. C. Falls (Fayette).

Maury, M. F. Jr. 1873. The Resources of the Coal Field of the Upper Kanawha. Sherwood and Co. Baltimore, Md.
Rare

The text contains a description of the coals and possibilities of mining. Some discussions focus on water power, timber and iron.

Maury, M.F. and William M. Fontaine. 1876. Resources of West Virginia. The Register Co., Printers. Wheeling, WV. 430 pp.
Rare

This text discusses all the marketable resources and their known values, productions, and potentials. A discussion of timber is done by dividing the state into regions and giving a comparative discussion on the distribution of certain species throughout each region. Pages 145-147 gives a discussion of the New River area. A few interesting points are brought out about the quality of timber as compared to other areas and a few of the species present.

Chapter VII discusses native species of trees, shrubs and medicinal plants. Info on trees includes how to market, best uses over

Best habitat for good growth, etc. Other discussions get into the topic of quality and varieties of coals, with special mention to New River on several occasions.

Millspaugh, C.F. 1892. Preliminary Catalogue of the Flora of West Virginia. West Virginia University Agricultural Station Bulletin 24. Morgantown, WV. 218 pp.
Libraries and Agency

A complete list of vascular and non-vascular plants known from West Virginia. Many of the collections were made by Nuttall who mostly collected near Nuttalburg in New River Gorge. The various stations for each species is given.

Millspaugh, Charles Frederick and Lawrence W. Nuttall. 1896. Flora of West Virginia. Field Columbian Museum Pub. 9-Botanical Series Vol. 1:2. Chicago, IL. 276 pp.
Rare

Contains a brief botanical history of West Virginia. A list of all known vascular and non-vascular plants in the State. Includes the first record of Fraser's Sedge at Nuttallburg.

The list of 980 fungi in the state are mostly from collections by L.W. Nuttall. A description of the habitats and host plants are recorded for the fungi. Many of the listed lichens are also from collections made by L.W. Nuttall near Nuttalburg.

Millspaugh, C.F. and David White. 1913. Part I-The Living Flora of West Virginia and Part II-Fossil Flora of West Virginia. West Virginia Geological Survey. Wheeling News Litho Co. Wheeling, WV. 491 pp.
Libraries and Rare

This descriptive history of botany and paleobotany lists five individuals who collected in the New River Gorge area from 1849 to 1911. This list updates previous lists of the vascular and non-vascular plants. The list includes plant locations of which many were made by L.W. Nuttall in the New River Gorge.

Morris, John S. and Ralph W. Taylor. 1978. A Survey of the Freshwater Mussels (Bivalvia: Unionidae) of the Kanawha River of West Virginia. The Nautilus Vol. 92:4. pp. 153-155.
Libraries

Thirteen species of clams were found in the upper reaches of the Kanawha River. All collecting stations were below Kanawha Falls. No literature records were found previous to this study for molluscan fauna on the Kanawha River.

Mory, Peter C., et. al. 1977. Coal Reserve Study-New River Gorge, West Virginia. US Department of Interior. 31 pp.
Libraries and Agency

This paper discusses all of the coal beds of the New River Gorge area and indicates the mined out area as well as the coal reserves of each seam. Some discussion centers on the feasibility of mining the various coal seams.

National Parks & Conservation Association. 1978. The National Park System: Thirteen Possible Additions. National Parks and Conservation Magazine Vol. 52:7. pp. 20-26.
Libraries and Organization

Selections for the 1978 NPS list of possible additions to the park system are described. The list includes the New River Gorge National River.

Northeastern Forest Experiment Station. 19[illegible]. Forest Statistics for Southeastern West Virginia. US. Forest Service. Upper Darby, PA. 35 pp.
Organization and Rare

This survey divides the region (includes New River Gorge), into five forest types. These types are: oak-hickory, cove hardwood, northern-hardwood, chestnut oak and softwood. Forest information includes: number of acres by forest type, timber size and stocking. Quality and quantity of timber is also stated.

Northeastern Forest Experiment Station. 1953. Forest Statistics for the Southeastern Section of West Virginia. US Forest Service. Upper Darby, PA. 16 pp.
Organization and Rare

An update of the survey conducted in 1949.

Northeastern Forest Experiment Station. 1978. The Forest Resources of West Virginia. Northeastern Forest Experiment Station Bulletin NE-56. Broomall, PA. 105 pp.
Libraries and Agency

A statistical and analytical report of the third forest survey of West Virginia. The findings are based on the remeasurement of fifth acre plots and new 10 point cluster plots. This report analyzes trends in forest land area, timber volume, annual growth and timber removals. There are 65 tables of statistical data giving statewide figures. Information presented for each county (including Fayette, Raleigh and Summers), is as follows:

1. Land area in forested, non-forested, commercial and non commercial types[illegible]
2. Area of commercial forest land by stand size class.
3. Area of commercial forest land by forest type.
4. Other values in timber production

Phillips, Glen. 1976. The 1975 Foray-Singing Male Population Studies. The Redstart Vol. 43:1 pp. 2-11.
Libraries and Organization

Two weeks of indepth studies of breeding birds in various vegetative types were conducted by members of the Brooks Bird Club. Information includes an inventory of the forest cover and the numbers of territorial male birds, identified in these cover types.

Phillips, Violet Josephine Siemionko. 1969. The Botany of the New River Valley between Glen Lyn, Virginia and Gauley Bridge, West Virginia. Doctoral Dissertation at West Virginia University. 128 pp. Photos of the various stations included.
Rare

This study describes an extensive study of the ecology, taxonomy and phytogeographic relations of the flora of New River. Plants which were systematically collected at thirteen stations over a three year period and throughout the growing season are listed. The report includes a literature search on the fossil flora of the New River. Summary narratives of historical geology and forest cover types are included.

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The cover type vegetation is broken down into hydric, mesic and xeric types. The dominant species of each cover type is given along with the associated shrub and herbaceous vegetation layers.

Contains a summary of previous botanical explorations in the New River area including, Russell Guy Brown and John Paul Tosh who collected in the Gorge.

Price, P. H. 1957. Natural Resources of West Virginia. WV Geological and Economic Survey Educational Series ED-1. Morgantown, WV. 19 pp. and 35 figures.
Libraries, Agency and For Sale.

Provides a discussion of West Virginia's minerals, soils, forests and water.

Price, W. Armstrong. 1916. Notes on the Paleontology of Raleigh, Wyoming and McDowell and Adjacent Counties. (Reprint of pages 663-736 of the book, "Raleigh County and Western Portions of Mercer and Summers Counties-Detailed County Reports). WV Geological Survey. Morgantown, WV. 74 pp.
Libraries and Agency

This study discusses the marine invertebrate fossils of the Pottsville Series known up to 1916. The information is useful to understand the Pottsville Series of rocks in the New River Gorge area. Discussion is based on fossils collected both inside and outside the study area. A table lists all known marine invertebrate fossils from the Pottsville Series in West Virginia. Information about the fossils includes a description of each species, geographic occurrence and relative

Reed, James R.,Jr. 1974. Stream Survey of District IV - Southeastern West Virginia. West Virginia Dept. of Natural Resources. Charleston, WV. 96 pp.
Libraries and Agency

Streams in eight counties, (including-Fayette, Raleigh and Summers), were surveyed over a 15 year period to inventory fishery resources. Information includes:

1. List of species
2. Species specifically found in New River drainage system
3. Water quality and fish population data
4. Miles of streams
5. Miles of fishable streams
6. Recommendations for stream improvements
7. List of public impoundments
8. Descriptions of individual streams entering the river
9. List of rare, endangered or restricted species
   a. New River Shiner (Notropis scabriceps)
   b. Kanawha minnow (Phenacobius teretulus)
   c. Kanawha darter (Ethestoma kanawhae)
   d. Finescaled saddled darter (Theostoma osburni)
   e. Tonguetied minnow (Exoglossum laurae)

Ridgeway, Thomas S. 1872. Geological Report of the C & O Railroad (Includes Map). 24 pp.
Rare

Contains a discussion of all minerals along the railroad and gives the economic potential of each. Some discussions center on coal and fire clay in New River Gorge. A chemical analysis of coal is included.

Rodgers, J. H., et. al. 1977. Invasion of Asiatic Clam, Corbicula manilensis in New River, Virginia. Nautilus Vol. 91:2. pp. 43-46.
Libraries

Information on the introduction and spread of an introduced species in the New River.

Rodgers, J. H. Jr., et. al. 1978. Influence o Thermal Effluent on Population Dynamics of Asia c Clam (Corbicula manilensis) in the New River, Virginia. Association of Southeast Biologists Bulletin 25.
Libraries and Organization

Information on the life history of this introduced clam found throughout New Ri

Rodgers, J. H., Jr., et. al. 1979. Invasion Population Dynamics of Corbicula fluminea in the New River at Glen Lyn, Virginia. Proceedings of the First International Corbicula Symposium held at Fort Worth, Texas on October 13-15, 1977.
Libraries

Rogers, William Barton. 1884. A Reprint of Annual Reports and Other Papers of the Geology of the Virginias. D. Appleton and Company. New York. 832 pp.
Rare

Pages 113-119 deal with "The Great Western Coal and Salt Region". A general description of the geology of Western Virginia is given. Particular mention is made of New River on page 116 where a comment is made of "diagonal lamination" of rocks in the cliffs of New River. Page 406 provides information on the carbon, volatile and ash content of coal seams on Sewell mountain and Mill Creek.

Sargent-Webster-Crenshaw & Folley. 1965. Fayette County, West Virginia Environmental Data-Preliminary. 27 pp.
Libraries

A discussion of forest resources of the county between 1949 and 1961 includes changes in the forest composition. A general discussion of water resources includes stream flow data, flow duration, and water temperatures.

Seaman, E.A. 1948. Fish, Fish Management, and Fishing in WV. Division of Fish Management, Conservation Commission of WV. Charleston, WV. 34 pp.
Libraries and Agency

A list of commonly caught game and rough fish species by drainage systems in the state. This study covered the New River but no significant information is given.

Sheldon, John L. 1939. The Lichens of West Virginia. Castanea Vol. 4. pp. 75-126.
Libraries and Organization

List of the lichens and their distribution and hosts as of 1939.

Skuce, Thomas W. 1930. Forest Types as Recognized and Used in West Virginia. Proceedings of the West Virginia Academy of Science Vol. 4. pp. 31-36.
Libraries and Organization

Divides WV into two forest types as follows:

1. Carolinian-south of the Great Kanawha
2. Allegheny-north of the Great Kanawha

This paper lists the most common species, their values and average board feet per acre.

Stauffer, Jay R. Jr., et. al. 1980. Aquatic Biological Survey of the New River-Virginia and West Virginia. (Unpublished Study prepared for the Elkins Office of the US Fish and Wildlife Service). 36pp.
Agency

Fifty-eight stations along New River were sampled for fish, crayfish and bivalve mollusks. Fifty-eight species of fish were collected. Discussions on the distribution of five endemic fish species known from the area are given. Six species of crayfish were collected and a discussion on their relative abundance and distribution is included. Six species of clams were identified. A discussion is given on the potential impacts which would result from hydropower development on the New River in the vicinity of the Bluestone Dam. Tables listing numbers of fish, crayfish and mollusks at each station are included.

Strausbaugh, P.D. and Earl L. Core. 1930. Some additions to the Millspaugh Checklist of West Virginia Spermatophytes. Proceedings of the West Virginia Academy of Science. Vol 4. pp. 38-48.
Libraries and Organization

The list includes the following plants found along New River:

1.	Carex muskingumensis	Nuttallburg
2.	Carex tribuloides Var turbata	Nuttallburg
3.	Carex festucacea Var brevior	Nuttallburg
4.	Carex dibilis	Nuttallburg
5.	Hibiscus moscheutos	Nuttallburg
6.	Liatris graminifolia	Nuttallburg
7.	Clitoria mariana	Cotton Hill St.
8.	Xyris arenicola	Cotton Hill St.
9.	Stachys salvioides	Cotton Hill St.
10.	Hieracium pratense	Marr Branch

Strausbaugh, P. D. and Earl L. Core. 1978. Flora of West Virginia. Seneca Books, Inc. Grantsville, WV. 1120 pp.
For Sale

This is the most comprehensive and up to date book of the WV flora. It includes keys, descriptions and drawings of the more than 2200 species of vascular plants in the State. Habitats, locations and flowering periods for each species is given. Collection dates and specific locations are given for the most rare plants.

Swank, W.G. 1949. Beaver Ecology and Management in West Virginia. The Conservation Commission of West Virginia. Charleston, WV. 66pp.
Libraries and Agency

Information included was as follows:

1. Life history
2. Ecology of beaver
3. Enemies
4. Construction of dams
5. Vegetation of ponds

Vegetation study of beaver ponds listed associated plants and their abundance at various ages of the ponds. One active beaver colony was reported for Fayette County.

Tucker, R. C. 1939. Bituminous Coal Beds in West Virginia. WV Geological and Economic Survey. Morgantown, WV.
Libraries and Agency

This chart consists of a columnar section showing positions, names and average thicknesses of all coal beds in the State.

Uhlig, Hans G. 1956. The Gray Squirrel in West Virginia. The Conservation Commission of West Virginia. Charleston, WV. 83 pp.
Libraries and Agency

An indepth study on the life habits, ecology, life history, foods, populations and management of the gray squirrel. No specific coverage of New River.

US Department of Interior. 1963. Feasibility Study for Development of a New River Gorge National Parkway-Virginia and West Virginia. National Park Service. Washington, D.C. 38 pp.

A description of New River Gorge between Narrows, Virginia and Hawks Nest State Park, WEst Virginia. Includes a very general description of the public lands, recreational facilities and possibilities for the parkway. Indepth discussion of the proposed Parkway concluded it was not economically nor geographically feasible.

US Department of Interior. 1979. Preliminary Habitat Evaluation Report of the Proposed Bluestone Pumped Storage Project, Location "G" of the Kanawha Authorization Study. Army Corps of Engineers. Huntington, WV. 51 pp. and 6 maps.
Agency.

This publication deals with an area of New River just above the proposed National River area. The study deals with forest cover types, animal habitats and their interrelationships throughout the study area. The information and conclusions are general enough to have some application to the New River Gorge National River in the Hinton vicinity.

US Department of Interior. 1980. Endangered and Threatened Wildlife and Plants- Native to the United States. Office of Endangered Species of the US Fish and Wildlife Service of the US Department of Interior. Washington, D.C. 8 pp.
Agency

Lists all animals and plants in the US including their location by state or region and status. This list is current as of October 1980.

US Department of Interior-Bureau of Outdoor Recreation. 1975. New River Gorge. Northeast Regional Office. Philadelphia, PA. 107 pp.
Agency.

This is an assessment of the recreational and environmental values of New River Gorge. Comprehensive assessments are made of recreation income, land use, coal mining, soils, etc.

US Geological Survey. 1976. Water Resources Data for West Virginia-Water Year 1975. US Geological Survey Water Data Report WV-75-1. Washington, D.C. 288 pp.
Libraries and Agency

Page 160 contains discharge rates for New River and several major tributaries. Maximum and minimum average rates are stated.

US Geologic Survey. 1976 and 1977. Open File Report of -77-76. Washington, D.C.
Agency and For Sale

This is a series of charts and maps by various USGS personnel which gives technical details of the following topics:

1. Geologic Map of the New River Gorge Area.
2. Structure Contour Map of Coal Bearing Rocks.
3. Stratigraphic Section of the New River Gorge Area.
4. Bouger Gravity Map.
5. Coal Resources in the Proposed Wild and Scenic River Area.
6. Coal Resources in the Proposed National Park Area and Adjoining Region.
7. Subsurface Maps of the New River Gorge Area.
8. Maps and Tables of Natural Gas Productive Intervals New River Gorge Area.
9. Geochemical Sample Localities Map and Distribution of Cobalt, Chromium, and Nickel, New River Gorge Study Area.
10. Map of Landslides.
11. Maps Showing Extent of Mining in the Fire Creek, and Sewell Coal Beds, New River Gorge Study Area.

This series contains the latest information on stratigraphy, coal and minerals, oil and gas, and landslide areas in New River Gorge. Each of these items will be very important in future planning of the New River Gorge National River.

United States National Park Service. 1980. Draft Land Acquisition Plan-New River Gorge National River. New River Gorge National River Office. Oak Hill, WV. 36 pp. plus 1-map.
Agency

This preliminary draft indicates the proposed boundaries of the National River. Also, included is the law creating the National River as well as the methodology to be employed to acquire the rights and interests which are to be protected.

US Senate. 1976. Hearings Before the Subcommittee of the Environment and Land Resources of the Committee on Interior and Insular Affairs. Washington, D.C. 297 pp.
Libraries and Agency

Includes a general interest article on New River's natural resources, scenic values, etc. General comments are made on geology, plants, and animal life. The article is: New River Country-Wild and Scenic, by Elizabeth Watson (Reprinted from National Parks and Conservation Magazine, February 1975. pp. 278-283).

US Senate. 1978. New River Gorge National River, West Virginia. Subcommittee on Parks and Recreation Report. 56 pp.
Libraries and Agency

Report of information on the New River Gorge Area.

West Virginia Department of Natural Resources. 1980. Big Game Bulletin- 1979. Division of Wildlife Resources of Department of Natural Resources. Charleston, WV. 54 pp.
Agency and Free

Includes research programs, hunting regulations, and hunting statistics for wild turkey, black bear, white-tailed deer, ruffed grouse, wild boar, bobcat, fisher and beaver.

WV Geological and Economic Survey. 1921. List of Coal Mines in West Virginia. WV Geological and Economic Survey. Morgantown, WV. 26 pp.
Libraries and Agency

Includes a listing of all coal mines in WV at the time. Listed by county, name of mine, and the nearest post office. It also has a table showing coal production in short tons, by county, for the fiscal year 1921.

WV Geological and Economic Survey. 1958. Map of Mineral Resources and Mineral Industries of West Virginia. WV Geological and Economic Survey. Morgantown, WV.
Libraries, Agency and For Sale

Map shows the areal distribution of coal, oil and gas, limestone, rock salt, gas storage fields, and locations of principal pipelines, coal mines, quarries, and gravel pits

WV Geological and Economic Survey. (Issued Quarterly). Surface Mines in West Virginia. WV Geological and Economic Survey. Morgantown, WV. About 50 pages.
Libraries, Agency and For Sale.

Provides basic index of surface mineral producers under permit in the State. Lists companies alphabetically and provides permit number, status, resource extracted, and quadrangle.

WV Geological and Economic Survey. (Issued Annually). West Virginia Mineral Industry Status (Preliminary). WV Geological and Economic Survey. Morgantown, WV. 8 pp.
Libraries, Agency and For Sale.

Provides tabular and graphical summary of non-metallic mineral and fossil-fuel production statistics for West Virginia. Also contains page-size maps showing the areal extent of known coal, limestone, salt, and oil- and-gas resources of the State.

Wetmore, Alexander. 1937. Observations on the Birds of West Virginia. Proceedings of the US Natiional Museum. pp. 401-441.
Rare

Expedition to various West Virginia locations to identify birds. None of the locations were in New River Gorge, though some were within 20 miles.

Zinn, Gary and Joel Sutton. 1976. Major forest Cover Type Groups of West Virginia. West Virginia Forestry Notes. West Virginia University School of Forestry. Morgantown, WV. pp. 3-6
Libraries and Agency

This article covers in detail the composition of four cover types in West Virginia. New River Gorge falls into the mixed mesophytic type.