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Southern Appalachian Streams.*

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As the streams of the Southern Appalachians are destined to play an important role in the industrial development of the South, I deem a consideration of their characteristics and salient features of sufficient interest to merit your attention to-night.

From the days of the Colonies until the time of the Civil War the South was essentially an agricultural community and little or no manufacturing was done. Events subsequent to the Civil War have changed the conditions, and the South is becoming not only the leading producer in the three great crops of cotton, rice, and tobacco, but it is forging ahead along industrial lines. Not very long ago cotton was exported from the fields of Alabama and Georgia to the factories of New England. It is now generally recognized that the better practice is to finish the raw product where it is produced, hence the

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factories have moved to the cotton fields. One of the most potent influences in the creation of the industrial South has been the perfecting of methods of transmitting electrical power long distances, and the generation of this power from the numerous rivers. The pioneer work in this line was done at Anderson and Pelzer, South Carolina, about 1895; I believe that it was in these two places that hydro-electric plants were first used to drive cotton mills. The experiment was watched with deep interest, and the results achieved were a stimulus to general development and application.

To arrive at a clearer understanding of the prominent features of the streams under discussion, it is first necessary to consider the physiography of the region. The Atlantic seaboard in the Southern States presents three types of formation. First, the Coastal plain; further inland, the Alluvial belt, and still further the Appalachian range of mountains, and while this chain extends from Maine to Alabama, and is variously known as the White Mountains, the Adirondacks, the Alleghenies, and the Blue Ridge, it is with the Blue Ridge that we are concerned this evening.

To the south of the Shenandoah Valley, in Virginia, occupying portions of Virginia, North Carolina, South Carolina, Georgia, Tennessee, and Kentucky, lies a tableland more than three thousand feet above the sea level, seventy miles wide, and three hundred miles long, known as the Southern Appalachian plateau. All of the important streams south of the Ohio River, in the Mississippi, Gulf, and South Atlantic drainage, trace their source to this plateau. The physical feature that differentiates the Southern Appalachians from the rest of the system is the way the rivers rise. Northern rivers, such as the James and Susquehanna, rise on the most westerly ridge and break through the intervening ranges, wending their way to the ocean. The New River, rising on the slopes of Grandfather Mountain, in North Carolina, in the most easterly range, and flowing into the Ohio, is the first stream to violate this law, and establishes a precedent followed by all other Southern rivers, hence we find all streams flowing north, south, east and west rising on the slopes of the Blue Ridge.

The plateau is bounded on the east by the Blue Ridge and on the west by the Unaka range. The eastern slopes of the

Blue Ridge are gradual and form the Piedmont section, noted for its richness and agricultural value. The Unaka mountains, on the other hand, are higher, more rugged, and cut by the rivers into innumerable gorges. Lying between the two ranges are sundry irregular cross ridges, called the "Blacks," "Craggies," "Balsams," "Cowees," "Nantahalas," and "Smokies." Contained in these groups are 275 peaks over five thousand feet high, and thirty-six exceeding six thousand. Conspicuous among the last is Mount Mitchell, the highest peak east of the Mississippi, and the oldest land on the American continent. The mountains are clothed to their summits with forests of the finest hardwoods. The flora is of the richest and most beautiful, due no doubt to the copious rainfall.

The rainfall over the whole area averages fifty or more inches per annum, and in the vicinity of Highlands, N. C., reaches the extreme figure of seventy inches. With the exception of Puget Sound, this is the greatest precipitation in the United States.

This tract, embracing approximately 10,000 square miles, is the natural reservoir that supplies, replenishes, conserves, and tends to make uniform the flow of all the rivers.

Uniformity of flow depends largely on the nature of the soil, the character and extent of the country drained, the presence or absence of lakes, and the distribution of rainfall. In the South lakes and glacial deposits are entirely lacking, hence the streams depend solely on the rainfall. Fortunately this is greatest in summer and least in winter, for in summer the requirements of plant life and the increased evaporation demand more water than the other seasons.

The rivers emanating from this plateau in the course of their length present three distinct types. First, in the mountains they descend rapidly, are confined in narrow channels, and abound in falls and cascades, along which portion they are susceptible of hydraulic development in innumerable places; their value for power purposes is, however, curtailed by the limited drainage area. The second stage is through the Piedmont section, where the streams contain their finest water power and are themselves of great magnitude, for miles descend shoal after shoal. This is the portion usually designated as the "Fall Line." The final stage is below the Fall Line, where

they lose their dynamic force and become navigable bodies of water.

The pre-eminent apex of the drainage area in the Southern Appalachian Plateau is Grandfather Mountain, in North Carolina. It is the highest peak in the Blue Ridge, and to its slopes four great rivers—the New, Yadkin, Catawba, and Holston,—trace their source. The New River, to which allusion was previously made, rises on the northerly slopes, crosses the State of Virginia, and after its confluence with the Gauley, is known in West Virginia as the Kanawha. Its head waters comprise the counties of Ashe, Watauga, and Allegheny in North Carolina. Its valley in the State of Virginia is famed for its beauty, and although the river possesses great fall, and its characteristics are well known, yet it is one of the least developed of the Southern streams. The proximity of the Virginia coal fields is doubtless accountable for this condition.

Considering the water courses in rotation, the next claiming attention is the Roanoke. This river is formed by the Dan and the Staunton at Clarkesville, Virginia, and while not strictly speaking a Southern Appalachian stream, it may be so classed, for although the Staunton does not drain the Southern Appalachian Mountains, the Roanoke's course lies wholly in the territory so drained. Neither the Staunton nor the Dan have any marked fall. The Roanoke crosses the fall line at Weldon, North Carolina, draining at this point more than 9,000 square miles, and the fall in nine miles exceeds eighty-five feet. If properly supplemented with steam 75,000 horse power could be generated in this locality, although its value for power purposes is limited to a marked degree by the violent floods and extreme fluctuations to which it is subject. The flood flow is often sixty-one times the minimum, an unusual condition in a stream with so large a drainage area. The Roanoke Rapids Power Company have developed the river to some extent, and are furnishing power to a number of industries in the town of Roanoke Rapids.

The Cape Fear, the river next in succession, claims the distinction of being the only large river, together with its tributaries, that lies wholly in one State. Formed at Moncure by the junction of the Deep and Haw Rivers, the Cape Fear crosses the State in a southeasterly course and empties into the At-

lantic at Southport, a town thirty miles below Wilmington. This river gets its name from the noted Cape Fear, a point dreaded by mariners almost as much as Cape Hatteras. With the exception of the Susquehanna, this stream is subject to greater floods and lower stages than any other stream on the Atlantic seaboard. The river is navigable as far up as Fayetteville, and previous to the general extension of the railroads attempts were made to increase this distance. A few miles above the town the fall line is encountered, and for thirty miles the river descends a succession of shoals.

The river is developed at a number of points, the power in every instance being used to drive mills in the vicinity. There is, however, an hydro-electric plant of some magnitude being constructed at Buckhorn Falls, the history of which is of interest. In 1796, the State granted a charter to the Cape Fear Navigation Company to erect dams, build locks, and render the river navigable in this locality. \$80,000 or \$100,000 were spent and practically nothing accomplished. The work was continued at intervals, and after passing through countless vicissitudes, and spending \$350,000, the project of navigation above Fayetteville was abandoned at the beginning of the Civil War. In part by natural causes, and in part intentionally, the works were destroyed. In 1868, the State appropriated the property to the Raleigh and Augusta Railroad Company. A little later it was bought by the Deep River Manufacturing Company, an interest largely controlled by the Lobdell Car Wheel Company of Wilmington, Delaware, who owned iron mines in the vicinity and were seeking water transportation. Between 1876 and 1880 boats were run occasionally, and since 1880 have ceased altogether. The difficulty throughout has been in getting the ends of the dams and the locks protected from freshets. The present owners, with the intention of developing electric power for transmission to Raleigh and Fayetteville, acquired the property in 1895. Lawsuits contesting the riparian rights, together with other unfortunate circumstances, have resulted in the complete tie-up of the property.

The Yadkin and Catawba, two rivers of prime importance, are next in order. A peculiar feature of these streams, and one common to numerous others, is that where they leave a

Fig. 1. Views of the Yadkin at the Whitney Reduction Company's plant: 1st, The Yadkin.
2d, The Bed after Diversion. 3d, Dam in Process of Construction.

State, they change their names, thus the Yadkin and Catawba of North Carolina become in South Carolina the Great Pee Dee and the Wateree.

The Yadkin rises on the southern slopes of Grandfather Mountain, is in all some four hundred miles long and empties into the Atlantic at Georgetown, South Carolina. The fall line is crossed at Cheraw, about 150 miles from its mouth, above which point falls and shoals abound, the most prominent being Bluit's Falls and the Famous Narrows. Both are being developed at present, the former by the North Carolina banking house of Hugh McRae & Company, who expect to secure about 15,000 horse power, and transmit to the milling town of Darlington; and the Narrows by the Whitney Reduction Company, a Pittsburg corporation. Probably the most striking hydrographic feature on any Southern stream is the Yadkin Narrows, the great river draining more than four thousand square miles of territory, and which in the vicinity of Salisbury, North Carolina, is nearly half a mile wide, at a point about twelve miles southeast of the town contracts to a width of one hundred feet, in places even narrowing to sixty feet, and for four miles roars and crashes in a gorge that it has worn down through the solid granite. The development contemplated consists of a dam some fifty feet high at the head of the rapids and a canal several miles long. Forty thousand horse power will be generated and will be transmitted at a potential of sixty thousand volts to the adjacent manufacturing towns.

Like Yadkin, the Catawba rises on the Blue Ridge, one of its principal tributaries, the Linville, traces its source to the southwestern slopes of Grandfather Mountain. The Catawba crosses the State line twenty miles south of Charlotte, below Columbia, together with the Congaree, it forms the Santee and empties into the ocean in the vicinity of Georgetown. The fall line is crossed at Camden, above which point an area of five thousand square miles is drained. From Camden to the foot of the mountains sixteen notable shoals are encountered. On ten of these developments are being projected at the present moment. The first hydro-electric plant built on this river was the Catawba Power Company's 10,000 horse power plant at Rock Hill, South Carolina. This property, with others, has been merged into a corporation known as the Southern Power

Fig. 2. Dam and canal of Southern Power Company's Great Falls plant, 30,000 horse power, Catawba river.

Company. With a paid-up capital of \$10,000,000, the Southern Power Company enjoys the two-fold distinction of being one of the largest power companies in the country and of being built with Southern capital. An ultimate development of ten plants with an aggregate capacity of 132,000 horse power is planned. Of this amount 122,000 horse power will be obtained from the Catawba River alone. The fact that there is a market for so great an amount of power impresses an observer with the titanic proportions of the New Industrial South, and when it is realized that this is but one company and one river the scope of the entire possibilities is not easily grasped. The Piedmont section is the manufacturing district of the Carolinas, and it is the heart of this territory that is controlled by the hydro-electric plants of the Catawba and the Yadkin. In a radius of fifty miles of Charlotte a conservative estimate of the hydraulic developments contemplated or in process of construction would be a total capacity of not less than 250,000 horse power. The amount and price of the power, the railroad facilities, the character of the population, and the salubrity of the climate are fast making this particular section the great manufacturing center of the South, and a district which in time will rival Lowell, Holyoke and other New England centers, even as Birmingham is now rivaling Pittsburg in the iron market.

The limited time precludes consideration of all of the streams, and although the majority possess enormous undeveloped power, and many are developed to some extent, a discussion of the Broad, Toxaway, Saluda, Savannah, and others must be omitted, and your attention next directed to the Chattahoochee, conspicuous in this instance as it is the first of the Southern Appalachian streams to reach the Gulf. Rising in North Georgia, the river for the greater portion of its length forms the boundary line between Georgia and Alabama. The Atlanta Water Power Company's Morgan Falls plant, distant some thirty miles from Atlanta, is at present the largest development on the river, and furnishes the greater part of the power used in the City of Atlanta. The North Georgia Electric Company, at a cost of upwards of \$7,500,000, propose to develop other powers on this river and also on its tributary, the Chestatee, and it is credibly reported that an immense de-

Fig. 3. Map of Southern Power Company's hydro electric plant and transmission lines.

Fig. 4. Atlanta Water Power Company's Morgan Falls plant, Chattahoochee river, 10,500 kilowatts 48-foot head, 20,000 volt, 30-mile transmission.

velopment is shortly to be made at Columbus, Georgia, where one large plant now exists.

Passing to the western drainage system, the first prominent stream to claim attention is the Little Tennessee. Rising in Rabun Gap, in Georgia, it crosses Western North Carolina and cuts its way through the Smoky Mountains. A characteristic of all Western rivers is the deep canyons they have cut through the Unaka range. In some past age the hills have been rent asunder, and the streams have slowly but continuously worn away the stone cliffs. At the North Carolina-Tennessee State line the Little Tennessee drains an area of two thousand square miles and for a distance of four miles in North Carolina is a roaring torrent falling a total of 240 feet. The river is comparable here with the Narrows of the Yadkin, and inferior only on account of the lesser drainage area and consequently the lesser amount of water. A development to the extent of 50,000 horse power is planned in North Carolina, which, taken with a projected development of 20,000 horse power a few miles across the State line, makes the river one of the most noteworthy power streams in the Western system.

Second in importance to the Little Tennessee is the French Broad. This stream rises in the Pisgah Forest, of the Biltmore Estate, and by reason of the protection the forests afford is freer from excessive floods and low minimum stages than any other stream. From Brevard to Asheville the fall is slight. A few miles north of the city the rapids begin and in a distance of forty miles the fall is seven hundred feet, while the area drained is about eighteen hundred square miles. Its value as a power stream is curtailed by the proximity of the railroad, which precludes the construction of high dams and limits developments to small units.

At this time there are but two hydro-electric plants in operation on the western rivers, one of these located at Asheville, on the French Broad, the other near Waynesville, on the Pigeon River.

A large hydro-electric plant is now under construction at Hale's Bar, on the Tennessee River, forty miles below the City of Chattanooga. The Tennessee River is formed a few miles from Knoxville, Tennessee, by the confluence of the French Broad and the Holston; at Chattanooga it counts as its tribu-

Fig. 5. Weaver Power Company's dam, French Broad river.

Fig. 6. Interior Weaver Power Company's plant, French Broad river.

taries the Holston, the Wautauga, the French Broad, the Big and Little Pigeon, the Little Tennessee, the Hiwassee, and a number of other smaller streams, including in fact the whole western drainage. Normally the river is navigable as far as Knoxville, although below Chattanooga pronounced shoals exist which interfere with navigation in certain seasons. The United States Engineers after years of study reported the most feasible method of improving the river would be the construction of a dam at Hale's Bar sufficiently high to back water to Chattanooga. Congress sanctioned the plan, and granted permission to individuals in Chattanooga to cooperate with the Government and to utilize the power so obtained for commercial purposes. It is anticipated that 50,000 horse power will be available, and the undertaking is a striking illustration of the excellent results that can be accomplished in improving our water ways where local interests and the Government work harmoniously.

This brief discussion would not be complete with a consideration of methods that will insure the future usefulness, and policies that will improve the streams of the Southern Appalachian plateau. Since nature has denied lakes it will be necessary to create artificial bodies of water. Lake Toxaway and Fairfield are examples of what may be accomplished at a reasonable cost, while primarily intended for pleasure resorts and to enhance the beauties of the Sapphire country they have incidentally proved to be most valuable in regulating the flow of the streams on which they are located. In the case of Lake Toxaway one inch of rainfall over its entire watershed will raise the level of the lake but ten inches, granting that all of the precipitation could immediately reach the lake, while with the confined limits of the overflow weir thirty or more days would be required to discharge this quantity of water.

Nature was lavish in her provisions of forests, but these are now being rapidly demolished, a fact that should be a matter of national regret. That the forests wield a potent influence on the flow of streams can be stated without fear of contradiction. Floods and low water seasons have always existed, and probably ever will, but it has been demonstrated beyond reasonable doubt that on streams where the head waters are protected by plant growth these conditions are reduced to a minimum.

The forests exert a fourfold influence on the streams; by the mechanical action of the trunks, limbs, and leaves, they break the fall of the raindrops; the roots keep the ground open and porous, thereby assisting percolation; the forest floor, consisting of the humus and debris, is from its hygroscopic nature a most excellent filter and preventative agent to the formation of rivulets and gullies, forcing the water to soak in and seek subterranean drainage; the cooler atmosphere of the forests appre-

Fig. 7. Ruthless destruction of timber in Western North Carolina.

ciably retards evaporation. This, however, is to a large extent offset by the amount of water required for transpiration when the trees are in leaf.

Since wood is more widely used by man than any one other material it would be ridiculous to assert that the forests must be protected to the exclusion of the lumbering industry, but it is not unreasonable to demand that the present crude and extravagant methods be superseded by more enlightened practices.

A greater menace, and more destructive than the lumber-

men are the annual forest fires, which kill the seedlings and undergrowth, destroy the floor, and preclude the possibility of the forest reproducing itself. Generally the fires may be attributed to carelessness, and only in the rarest instances is malice the cause.

The small agriculturalist is almost as serious a factor as either the lumberman or the fires. The mountain sides by reason of their steepness are unsuited to agriculture, and are abandoned after a few crops as the fertile soil has been washed away and erosion ensued.

It is erroneous to suppose that a primeval forest of gigantic growth is essential to the preservation of a stream. Any growth that meets the four requirements previously mentioned and excludes agriculture is all sufficient. In my opinion a low copse growth is to be preferred. Ere long it will be necessary to replant many districts, and the cost and most suitable trees will be the subject of much discussion. At present afforestation is conducted on the Biltmore Estate at the small cost of \$15 an acre. The plantings are usually white pines, and a growth of marketable timber is anticipated in about twenty-five years.

The measure to establish a Southern Appalachian Forest Reserve now before Congress is most commendable, and is probably the only solution of the problem of preserving the forests, and incidentally the streams, for the National Government rather than the State can exercise a more far-reaching control, replant denuded tracts, and organize a system of fire protection. The rivers being interstate waterways, their protection should from the nature of the case be a national matter.

In conclusion it may be stated that the streams issuing from the Southern Appalachians are capable of being developed to the extent of 1,000,000 horse power, while 200,000 horse power would be an extreme figure for the amount now in actual use, and were it possible to market the entire power an annual income of \$30,000,000 would be derived. On the plateau there falls each year sufficient rain to make a lake four feet deep over the entire States of Rhode Island, Delaware, and New Jersey. To conserve this rainfall and to develop the enormous powers are the problems with which the South is now deeply concerned.