More than a Waterfall

The Story of White Oak Canyon Nature Trail, an Experiment in Nature Education

By BERNARD FRANK and IVAN TARNOWSKY

Photographs by Devereux Butcher

The authors and pioneers of this trail pose beside the sign that marks the start of the trail. They are all dressed up for trail-going.

WHOEVER walks down the White Oak Canyon Trail—Shenandoah National Park's most popular hike—will see at the end of the trail a magnificently beautiful waterfall. Even in dry weather the falls keep flowing. In the hottest time of Virginia's summer the walk down the trail is cool and refreshing, and the goal is satisfying and inspiring throughout the gentle climb along the return trail. Thousands have followed this trail and returned feeling well rewarded simply by the walk itself and the view of the falls.

But there is more to any outdoor excursion than scenery and exercise, and visitors to the White Oak Canyon Trail now have an opportunity to realize that there is more here than a waterfall and a pleasant hike, and much that has an important meaning to everyone. They owe this opportunity to an experiment The Wilderness Society has made in cooperation with the National Park in order to help the visitor guide himself to an understanding of Nature at first hand—to help anyone answer not only the question "What is it?" but also explain the "why" and the "how." Hundreds of people who visited this trail in 1947 tested out the experiment and made suggestions for its improvement. All agreed that if you know what to look for there is more here than a hike and a look at waterfalls.

A common question has been: "How did this start?" And its origin does seem significant.

The idea was first advanced by Benton MacKaye, father of the Appalachian Trail, footpath from Maine to Georgia from which White Oak Canyon Trail leads off on a side excursion. Elected president of The Wilderness Society in 1945, Benton MacKaye began facing the Society's problem of broadening an appreciation of our few remaining wilderness areas. It was no new problem to him, but one that he had already concluded was due largely to the fact that so few had learned to understand Nature at all. Thus he began anew to think of some way whereby people themselves could begin to read Nature itself, not merely books about Nature—and thus this trail was first visualized.

Soon Mr. MacKaye was writing Edward D. Freeland, Shenandoah National Park's Superintendent.

The response was enthusiastic. The Park staff, particularly Assistant Chief Ranger Francis A. Moore, and District Ranger Thomas K. Garry, cooperated unstintingly with the two representatives of The Wilderness Society (authors of this "preview") who undertook to carry out the project. Others also gave eager cooperation. Raymond S. Gregg, Chief Naturalist then of national capital parks, made many helpful suggestions. Miss Catherine Landon typed and retyped the project outline. The National Park Service and the U. S. Forest Service gave encouragement. The National Parks Association gave its support, and Devereux Butcher of that Association made the photographs.

AS A MODEL for similar projects elsewhere the White Oak Canyon self-guided Nature trail is of considerable general interest. The National Park Service and the U. S. Forest Service are accordingly calling it to the attention of their field staffs, and the American Nature Association has for the same reason arranged to present this picture-preview to the readers of *Nature Magazine*.

Here on this trail Nature, indeed, has a wondrous story to tell, for Nature itself is like a book to those who care to read. The White Oak Canyon Trail now opens this book at seven of its pages, selected for the particular interest and enjoyment of the "reader."

This picture preview "translates" these pages into the most elementary terms of English. But here are only words and pictures—not the things that the words represent. You know the word "topsoil." Maybe you even know, in words, all about topsoil. But do you know topsoil when you see it? Can you tell it from subsoil? The opened pages along this trail—its seven reading posts—invite you to study the reality, not the translation.

Here, then, is a preview in English. The purpose of the trail itself, however, is to give every visitor an opportunity to read, for himself, Nature's story.

GONE WITH THE RAIN

Post One

There is a post with holes.

The visitor looks through hole A; sees the exposed red oak roots.

He looks through hole B; sees the gully through which the soil feeding the roots is washed away forever.

What is happening?

Here is an example of man-made erosion. Bare soil near the oak roots is ready to be splashed loose and washed away by the next rain. Twelve inches of life-giving topsoil already have been washed away in a few years; washed away because man—before this was a National Park—took poor care of the land.

What is the effect?

Nature took some 5000 years to make this 12 inches of soil. Through man's abuse it washed away in a few years. No soil means no trees, no grass, no storing of water, no permanent waterfalls for you to enjoy.

The visitor travels to the next post, about a 15-minute walk.

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GULLIES are a sure sign of poorly-cared-for land. This gully, 14 feet wide and about one and one-half feet deep, extends for 100 yards before it disappears in the forest below. Notice the exposed roots of the red oak alongside it. Twelve inches of good topsoil have already been lost from this spot.

Before this park was established, the land was mostly in farms. Some crop land was ploughed up and down hill. Pastures often were grazed too heavily, killing off the grass and causing the soil to pack down. When hard rains came, they fell on bare or packed soil. They splashed particles loose, sealed up the surface pores of the soil, and carried precious topsoil downhill. On their swift path the rains cut little rills. Later the rills were deepened and widened into gullies. For many years this gully also has carried drainage water from an old road above.

Frost has helped enlarge this gully. During winter, the moisture in the bare soil freezes and expands, raising the soil into little pinnacles. When thaws come, as on warm, bright days, the ice melts and the pinnacles are carried off by moving water.

Now a good plant cover is returning to protect the soil in the area above the gully. Gradually more water is going into the ground and less is rushing off on top. In time the sides of this gully may heal, but meantime some soil will continue to be washed away.

Subsoil from thousands of gullies has found its way into stream channels, spoiling fishing and aggravating floods. Good farmlands along the Rapidan and Rappahannock river bottoms have been covered with sand and gravel. Rushing flood waters have carried sterile material clear down to Chesapeake Bay, causing damage to the valuable oyster beds there.

It takes Nature several hundred years to build one inch of the valuable topsoil that gives us food, clothing and shelter. But when forests are overcut, or burned, or when the land is improperly cultivated or overgrazed, several inches can be quickly lost in one hard rain.

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CANYON GETS NAMED

Post Two

Notice the large tree on the right.

This is a white oak. Notice the whitish-gray bark and the rounded lobes of the leaves. These trees were once abundant in the valley below, hence the name White Oak Canyon. This sturdy oak is well anchored by a taproot going several feet deep. Most of the roots, however, are near the top as seen at the last stop.

What is happening?

Plenty is happening within the trunk. Minerals and water in the life-giving soil are sucked through the roots, transformed into sap and up and up through the trunk to all the leaves. Compare with exposed red oak roots at the last stop; these can take up no minerals or water. This tree has been growing for 250 years. When this white oak was a sprouting acorn only Indians roamed these parts.

What is the effect?

Without white oaks along with other plants, no holding the soil together on the slopes; no reserve of water; no beautiful falls. (Eventually destruction of the farms below—less food or no food for you.)

The travel time to next post is about 15 minutes.

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ONCE this canyon contained many large white oaks. Even larger and taller ones grew in the richer and deeper soil of the valley below. Fine farms were cleared from such land.

This tree is 250 years old. It started from a tiny acorn around the year 1700. The soil here is about 3 feet deep. Most of the roots go less than two feet down, except for the deeper taproot.

White oaks shed their round-lobed leaves each fall. During the winter no food is manufactured, but activity still goes on. Water is being taken up from the moist soil, buds are developing and sapwood is changing to strong heartwood.

Spring and summer are busy times. Tiny root hairs admit more water containing soil minerals. This flows up through roots, trunk, and branches to the leaves, which act as "food factories." By the energy of sunlight, chlorophyll (green coloring matter of the leaf) combines substances from the air with water and minerals to produce starches, sugars and proteins.

A layer of new wood is added along the entire length of the tree, from the ends of the roots to the very tips of the outermost twigs. This growth takes place between the bark and wood inside the life-giving, paper-thin cambium layer. If this living tissue were destroyed, the tree would soon die. Fortunately, Nature has protected it with a sturdy outer bark—otherwise the tree could not survive the heat and cold of the seasons, and would quickly be killed by fires that occasionally result from matches, cigarets, or pipe embers carelessly tossed away.

White oak is a valuable plant. Its acorns furnish food for wildlife. Squirrels and chipmunks bury acorns —many trees are planted this way. Hollow trees, especially if near water, shelter families of 'possums and raccoons. Oak leaves and twigs furnish phosphorus, potash and other minerals in the soil. The roots bind the soil and help it to absorb and store more rainfall.

Alone, or in its natural forest setting, the proud white oak imparts strength and beauty to the landscape.

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OLD HEMLOCKS

Post Three

Notice the large trees on the left.

Hemlock is the name for these grand old trees. In contrast to the white oak, they stay green the year round.

What is happening?

The larger ones are about 300 years old. In contrast to the white oak as at the last stop, these hemlocks feed in only a few inches of soil spreading their roots all around. As in the white oak, the sap is moving up through the trunk of the hemlock—way up to the needles. With the help of sunshine needles manufacture food, which moves down as sap along the outer edges of the trunk to be stored for future use.

What is the effect?

Hemlocks, like the white oak along with other neighboring plants, hold and improve the soil. Improved soil stores more water from rains, steadily feeds the waterfalls below.

THESE large old hemlocks started life 300 years ago, long before white settlers came into the Blue Ridge. Some grew from seeds that fell on top of an old, rotten log. Hemlock seedlings commonly start on moist litter under heavy shade. These friendly evergreens, saved from axe and plough, live on for our enjoyment. If not damaged they can exist for another hundred years. They are long-lived, by contrast with some kinds of trees, whose life span may be under 50 years.

Notice the appearance of the woods away from the road. Trees alone do not make a forest. A true forest also consists of shrubs or other small plants, the litter, the topsoil, the birds, mammals and insects.

The nature of a soil reflects the plants that grow upon it. Under a hemlock forest it differs from that under an oak forest. It is not as rich; it has fewer earthworms and bacteria; and it is more sour or acid than the soil of protected hardwood forests.

Unlike white oaks, hemlocks have no taproot. Their roots are very shallow and spreading, seldom going 12 inches deep. They are "heavy drinkers." They prefer to keep their roots wet! This is why you usually find them along stream banks and flats where the water table is close to the surface.

Hemlocks are useful plants. Their crowns furnish good nesting places; the seeds of their small cones are relished by many mammals and birds. Their lacy, green foliage and rough brown bark lend color.

Notice the trampled condition of the ground. This was caused earlier by road travel and grazing animals and more recently by the many people who have stopped to admire the trees at close range. Such trampling injures the soil by closing its "pores," thus preventing air and water from getting to the roots. If this damage continues, the trees may sicken and die. However, by protecting the trees for a few years and by covering the packed soil with plant litter or a sawdust mulch beneficial conditions can be restored.

MYSTERY OF THE GROWING STREAM

Post Four

Notice the clear water.

In contrast to the muddy water that flows during rains in the gully of Stop One, this water is clear; it does not carry away life-giving soil.

What is happening?

Right before your eyes water is seeping into the stream—all along its length from under the mossy banks—water that has come from the slopes above—stored in soil enriched by trees and other plants, as pointed out at the last two stops.

What is the effect?

This clear flow will go to feed White Oak Falls—then down past the farms in the valley below where it helps to supply water for many useful purposes.

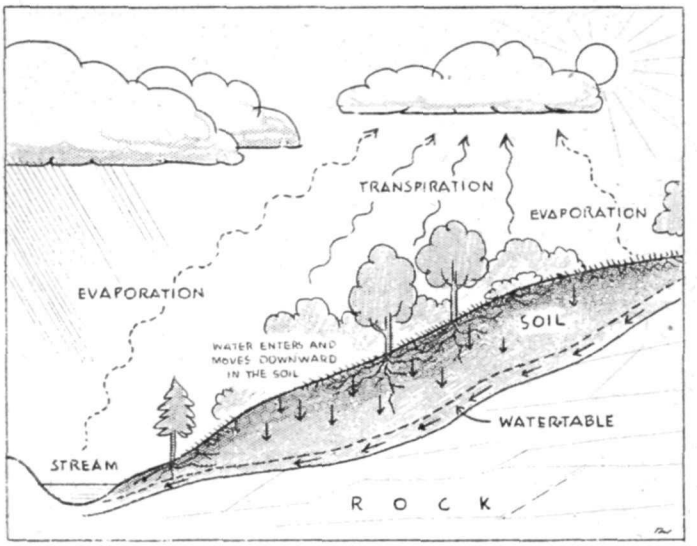
The travel time to next post is about 10 minutes. As you go, notice how the stream has grown.

HOW A STREAM GROWS

THE stream has grown noticeably larger than where you first crossed it above. It is being fed by underground water. This water represents part of the rain that fell on the land and soaked into the ground. Some was taken up by plants; some was evaporated by the sun's heat. (During the growing season much more water is used by plants than in winter.) Another portion began to move leisurely down through the soil, later coming to the surface in the stream channel. The same thing is going on all along the banks of the stream.

Wherever the soil is bare or packed down, however, rain waters rush over the land surface directly into the channels, tearing loose and carrying much soil with them. Such waters muddy up the stream and cause rapid rises. Floods often happen this way. During rainless periods the same stream may dry up, as there is no extra water within the soil to seep out and keep it flowing.

Notice the contrast between the stable banks of this stream and the crumbling sides of the gully at Stop One. Here the banks are mossed over, and firmly held by the roots of plants. The stream bottom is clean. Such clear, cool, shaded water is ideal for fish and the plants and insects they feed on.



SOIL STORES WATER

Post Five

Notice the various layers of soil.

The soil is dark on top, lighter below. Here before your eyes is all the soil we have; one which could be washed away in a few years by man-made erosion as shown at the first stop.

Handle the topsoil and subsoil in the box. Notice the difference in feel. Topsoil is light and crumbly and very absorbent; subsoil is heavy, tight, and slowly absorbent.

What is happening?

Plenty is happening in this soil. First when it rains, water goes gently through the absorbent topsoil until it hits the tighter subsoil below—the soil absorbs water like a blotter. Part of this water is "pumped" up by trees and other plants; another portion slowly seeps downward to feed the stream.

What is the effect?

Without the soil, we would have no water storage, no continuous clear, sparkling falls.

SOILS vary greatly over different parts of the earth. They differ as climate differs. There are forest soils, grassland soils, and desert soils. There are upland soils and bottomland soils.

The drawing shows the layers of a hardwood forest soil. On top is the litter—recently fallen leaves and twigs and the remains of dead plants, animals and insects. The litter is extremely important. It furnishes the food necessary for the life and health of the soil. The same plants that produce it each year protect it from drying up or blowing away. Without litter the soil would become sterile, pack down, wash away.

Beneath the litter is a decaying layer—here 2 inches deep—composed of old leaves, twigs and other vegetable and animal matter. Literally billions of insects, earthworms, "thousand leggers," spiders, ants, mites, other tiny animals, and bacteria feed on this material, carry it down into and mix it with the deeper layers. Tiny plants called fungi grow in it; their feeding parts spread in all directions. These animals and plants are Nature's true soil cultivators. The greater their number and variety, the richer the soil is. They work the whole year round, even in the cold of midwinter.

The third layer, here about 3 inches deep, is a mixture of humus and mineral matter. The greater the humus content, the darker is this layer—also the richer and healthier. Most plant roots—even of the largest trees—are found in or near this layer.

These three layers, together, make up the topsoil—here 6 inches deep. With its air, water, humus and minerals, topsoil is our most precious resource.

The fourth layer is the subsoil. This lighter-colored zone contains much less plant and animal matter—mainly the deeper roots and such creatures as earthworms, insects, and a few smaller mammals from the layers above. Root and insect and other tunnels are found as deep as 29 inches. The upper part of this layer has been leached of its minerals.

This layer is not as productive, nor can it take in water as fast as the layer above. But it, too, is useful. It provides anchorage for plants and a source of water and minerals. Under a good forest—one protected from fire, heavy cutting and especially from livestock grazing and careless logging—this layer is gradually enriched from above, becomes topsoil.

Still deeper are found few or no roots, many more pieces of stone and finally solid rock. This layer has more clay and is therefore tighter than the soil above. It takes in water slowly, and has less animal activity.

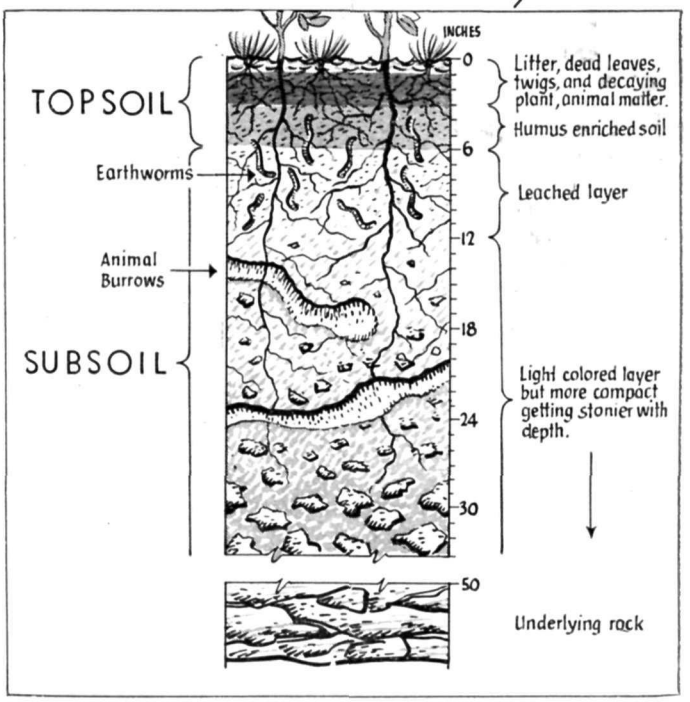
Rain water goes in gently through the litter. First to absorb it is the decaying vegetable matter. Then the topsoil begins to fill. The first six inches of topsoil under a dense, well-cared-for hardwood forest can hold well over three inches of water in its many pores and channels. Only when this layer has absorbed all the water it can hold, does the rest pass down. The subsoil takes its share but not as much, inch for inch. Any excess water moves down to the "water table." (The water table is the very wet layer found wherever water collects on top of rock or other tight material which it cannot penetrate.) The water then starts moving down hill underground, later coming to the surface either as springs or into stream channels, as shown at Stop Four.

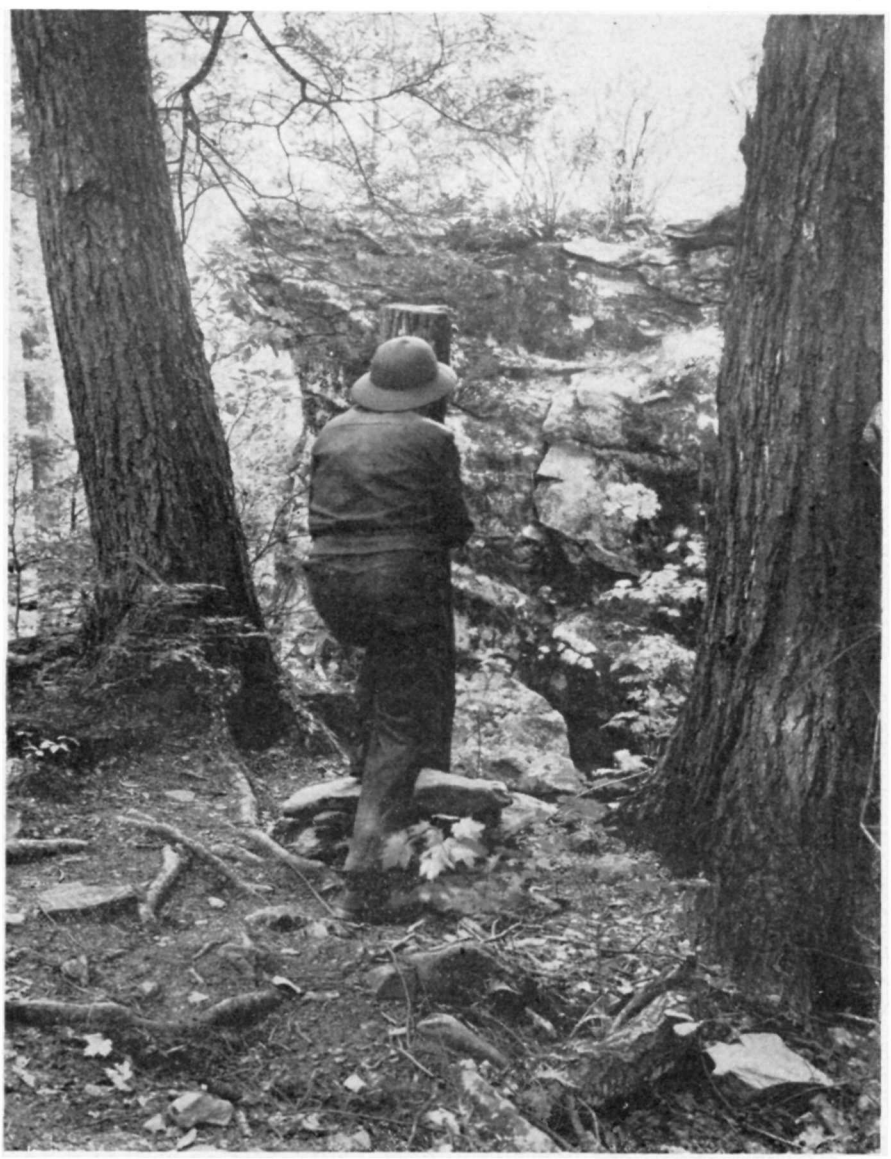
Slowly moving underground flow maintains well-water levels, keeps springs and streams running during dry spells. It yields the clearest and purest drinking water. It helps fill storage reservoirs. It provides steady streamflow for hydro-electric power even when no rains have occurred for some time. Without such flow, White Oak Falls would often go dry.

This well-forested soil absorbs the heaviest rains that occur. It does not freeze deeply nor solidly; it takes in water from rain or melting snow even after a severe cold spell. However, the same soil cleared and planted to crops or beneath over-grazed pasture or mistreated forest would freeze deeply and solidly after a severe cold spell. In such cases, water would quickly run off over the surface and directly contribute to severe winter and spring floods.

A CUT OF THE SOIL

in White Oak Canyon





SOIL BUILDERS AT WORK

Post Six

Notice post with holes.

Look through hole A — Notice lichens
Look through hole B — Notice mosses
Look through hole C — Notice ferns
Look through hole D — Notice shrubs and small trees

What is happening?

Tiny air-borne lichen "seeds" invade the bare rock. Lichens grow and "eat" into surface of rock. Mosses then appear and crowd out lichens. Ferns flourish on the decaying mosses helping to make soil. Finally enough soil is built to support flowering plants, small shrubs, later larger trees. All soil of this mountainside was originally created this way. Columbus had not crossed the ocean when the first lichens began to work on this rock.

What is the effect?

Without this process our world would be barren and lifeless. No steadywater falls. No soil, no plants, no food, no you!

The travel time to next post is about 25 minutes, and, as you go, you notice full-size hemlocks growing on rocks.

VARIOUS kinds of plants are growing along the sides and on top of this huge rock. They are helping to break it down into fertile soil.

Soil has formed here by the same processes which have been going on at Stop Five. First, water, heat and cold cause the rock surface to flake off into coarse particles. Acids in the water eat into the pieces, making them still finer. This process is helped by the coming of windblown "seeds" of simple plants called lichens which sprout and fasten to the rock. Several kinds of lichen grow along the side and on top of the rock. These tough plants need no soil and extremely little water. They stand great extremes of heat and cold. They release acids which dissolve the rock particles. As they grow and decay they also produce vegetable matter or humus. Rain falling on this mixture of mineral particles and humus makes it possible for other, slightly larger plants such as "reindeer moss" and other true mosses to grow on top of the lichens. These plants in turn, helped by bacteria and other tiny soil life keep adding humus and building more soil to catch and hold air and water. Then still more exacting plants—wild carrot and other herbs, and later Christmas fern and bluegrass—get started from seeds carried by wind or by animals. Each group of plants improves the living conditions for the next higher group and is in turn replaced by a richer and more varied growth. Meanwhile, the number and activity of tiny soil-plants and animals are speeding up. Enough soil is built to support shrubs like ninebark, prickly ash, raspberry and others, and finally the taller and more exacting plants, like the small black birch trees. As time goes on, more soil is created from the rotting rock beneath and rich topsoil created from above, as found at Stop Five, and the number and variety of plants will increase until a complete forest soil has developed.

Here is a miniature example of how Nature makes soil and permits plants and their animal relatives to flourish. Even in this moist, cool climate, the advancement of plant life from the simplest lichens to the most highly developed forest requires a long, long time. It may have taken at least 1000 years to form the 3 inches of rich, black soil on top of this rock.

A few feet uphill you will obtain a good view of the top of the rock.

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WATER THE SCULPTOR

Post Seven

Notice how falls curve around.

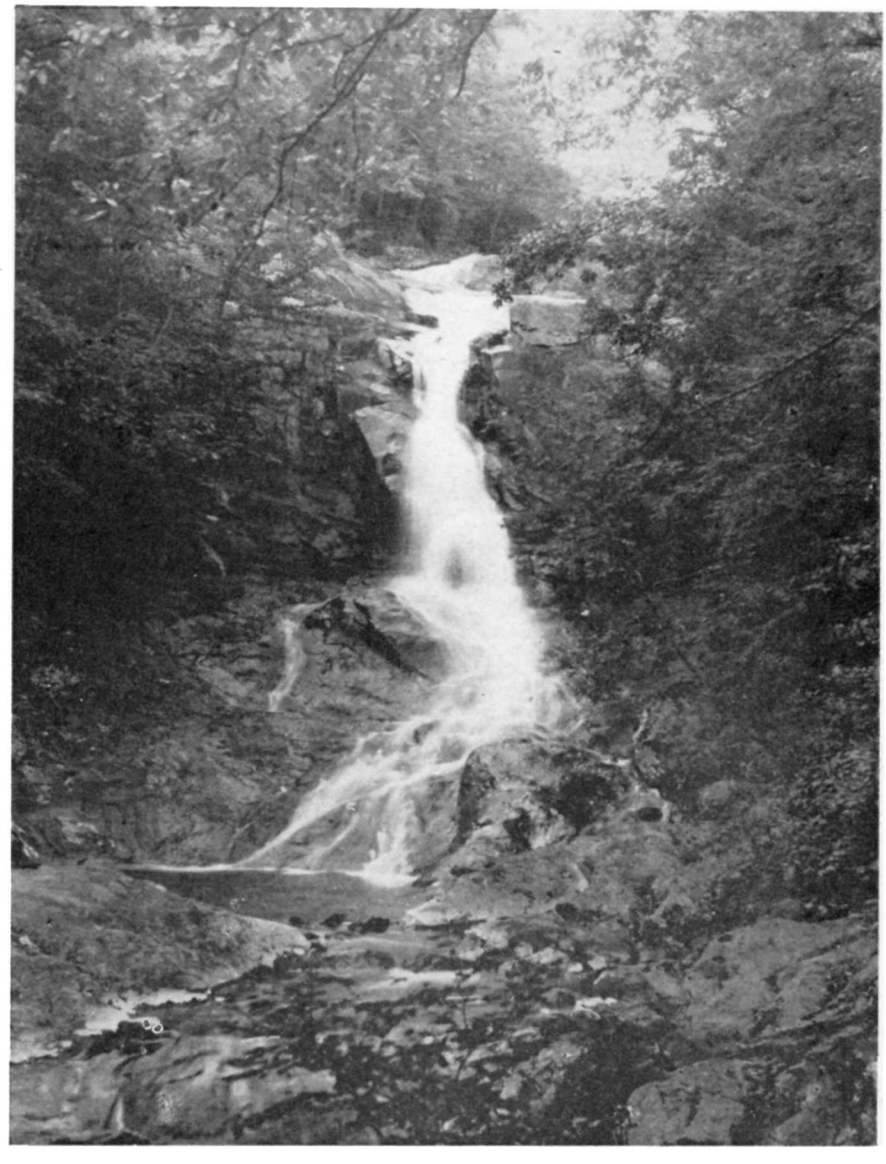
Observe the deep canyon at your feet.

What is happening?

The water does not flow down in a straight line—it curves around, wearing and grinding the softest rock more rapidly. Nature, as all of us, takes the easiest way. At your feet the canyon was started because of gigantic earth movements. It is being slowly cut deeper by the water. Nature has plenty of time.

What is the effect?

Waterfalls—enjoyment of the eye and ear. Compare its soothing sound with sound made by shouting aloud the letter "E."



WATER THE SCULPTOR

WHERE the slope of the land steepens, water speeds its flow. Its cutting power is greatly increased. Once the cliffs that flanked the canyon did not exist. Over the past millions of years flowing water has gradually cut through the massive rocks to create them.

The rushing waters are gradually chiselling down the stream bed. They are picking up small grains of rock and sand, using them as tools to grind and polish and to wear it down. Only when the valleys become less steep far below is the stream unable to cut so strenuously.

Gigantic earth movements, which tipped and folded the massive rocks of the earth's crust many millions of years ago, made it possible for the falls to form. Then falling water began its work. When it found a layer of softer rock on its downward course it began cutting more rapidly, making the steeper part of the falls. When the water met another hard layer beneath it cut more slowly, resuming its previous gentler grade. The winding and twisting of the stream result from weaknesses in its rocky bed. Wherever the water finds a crack or soft layer, it gradually makes a new channel.

In time, the hard rock above the falls will be undermined and break off. The falls will move farther and farther upstream; the rapids above and below will gradually smooth out. Eventually, the stream will carve a path far below the present level. Unless new earth movements occur, the whole mountain will wear to almost a plain and instead of a steep, narrow valley the visitor of some millions of years hence will see only a placid water course wandering slowly over a wide, flat valley.

Why is the sound of the falls so soothing compared with "E"? Shouting "E" produces a pitched sound having a typically high frequency. The falls, by contrast, create an "unpitched" sound composed of a variety of frequencies. When sound "E" reaches the ear it is like being struck by a sharp object—it hurts. But the effect of the falls on the ear is like being gently patted—it is pleasing.

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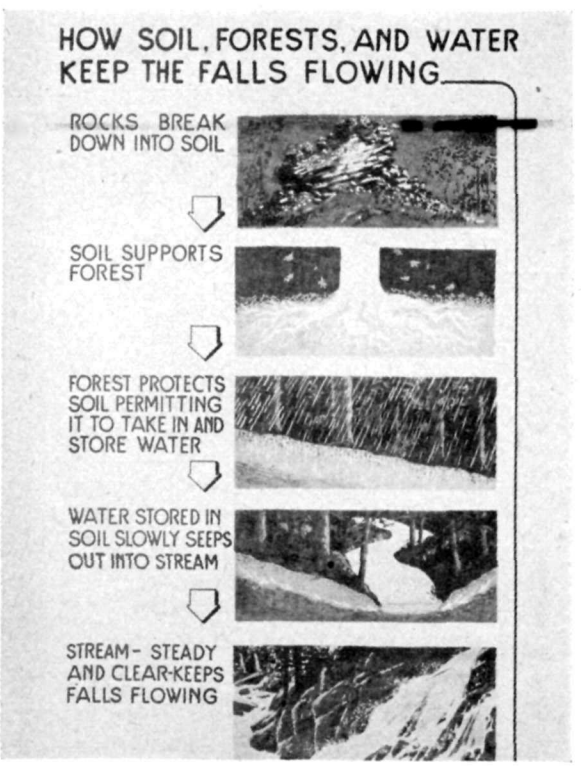
LET'S LOOK AT THE WHOLE PICTURE

THE trip down the canyon has revealed some of Nature's marvelous workings. The seven stops are all closely related parts of the same story. The landscape and the soils, waters, plants and animals are products of the climate and the underlying rock. Constant, natural change, however slow, is going on everywhere. No one can stop it, even if he were foolish enough to try.

Too fast a change, however, is bad. For instance, if we recklessly destroy a forest and expose its soils, a great many things happen. Many forest birds and animals lose their homes and disappear. The soils, robbed of their protection and plant food, are unable to take in and store water normally and to regulate the flow of streams. Numerous gullies soon form on the slopes. The streams no longer flow clear the year round. During rains, muddy waters rush madly off, tearing boulders loose and ripping the banks. During dry periods flow shrinks to a trickle, or disappears altogether; no water dashes over the falls. Fish can neither spawn nor find food in that kind of a stream; the water may even be too hot for them to live in. Altogether a great many unpleasant things can happen when we are foolish enough to disregard Nature's laws.

By learning to understand and respect Nature's ways we can do much to make our stay on Earth more pleasant, and help make it a more decent place for our children and grandchildren to live in.

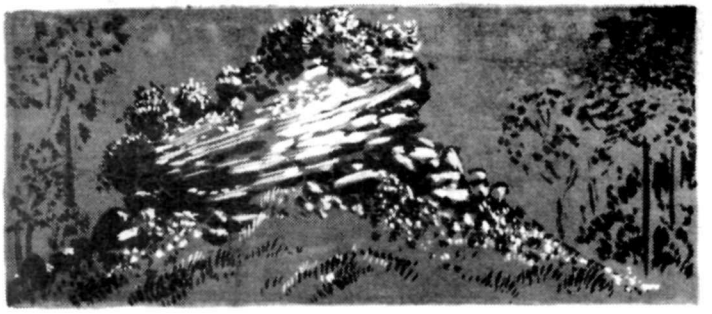
Fortunately, creation of the National Park assures protection of all natural features for the benefit of coming generations.



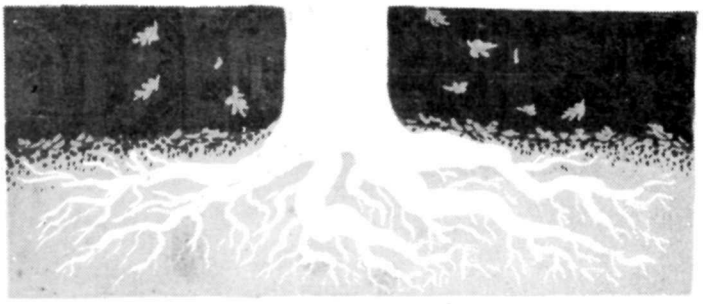
WHITE OAK CANYON NATURE TRAIL IS THE FIRST OF ITS KIND TO BE ESTABLISHED IN THIS PARK. FOR THIS REASON WE WOULD GREATLY APPRECIATE ANY COMMENTS, SUGGESTIONS, OR QUESTIONS YOU MAY HAVE, AS VISITOR OR READER OF THIS STORY OF A TRIP ALONG THE TRAIL. SUCH WILL HELP US TO MAKE THE NATURE TRAIL MORE INTERESTING AND ENJOYABLE, OR TO HELP OTHERS TO DEVELOP A SIMILAR TRAIL.

HOW SOIL, FORESTS, AND WATER KEEP THE FALLS FLOWING

ROCKS BREAK DOWN INTO SOIL

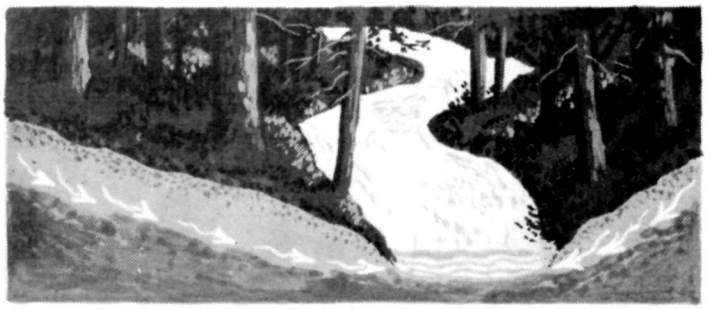


SOIL SUPPORTS FOREST

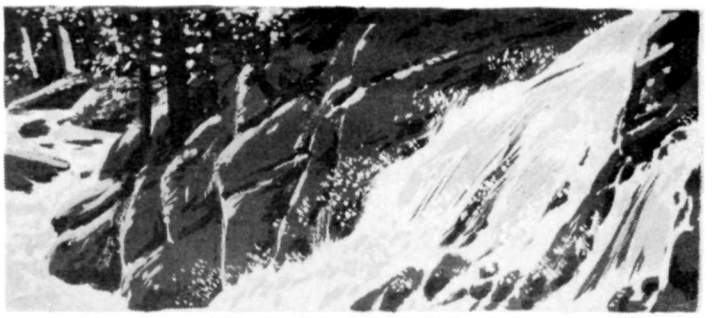


FOREST PROTECTS SOIL PERMITTING IT TO TAKE IN AND STORE WATER

WATER STORED IN SOIL SLOWLY SEEPS OUT INTO STREAM



STREAM- STEADY AND CLEAR-KEEPS FALLS FLOWING



DRAWN By T.C., U.S.F.S., W.O. 1947