What the NATIONAL FORESTS *Mean to the* WATER USER

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WHAT the National Forests mean to the water user may be summed up in the one word "service"—service that is none the less real because it is not always obvious and because its exact value can not always be expressed in dollars and cents. Every user of water which originates in the National Forests—and this includes by far the greater number of water users throughout the West—must look to the Forests for safeguarding his supply.

industries and approximately twice as much as the output of precious metals. California, the "Golden State," contributes annually nearly four times as much wealth in crops as in precious metals.

If the precipitation were as evenly distributed in the West as it is in the East, there would not be the need for irrigation that now exists, and the main purpose of the National Forests would be simply timber production. But it is not evenly distributed, and that is where the trouble lies. Except for a narrow strip along the Pacific coast from San Francisco north to the Canadian line, the great bulk of the precipitation occurs in the mountains. Throughout the Coast Ranges, the Cascades and Sierra Nevadas, and the Rocky Mountains and Colorado Plateau the rain and snowfall is far greater than in the intermediate valleys and plateaus.

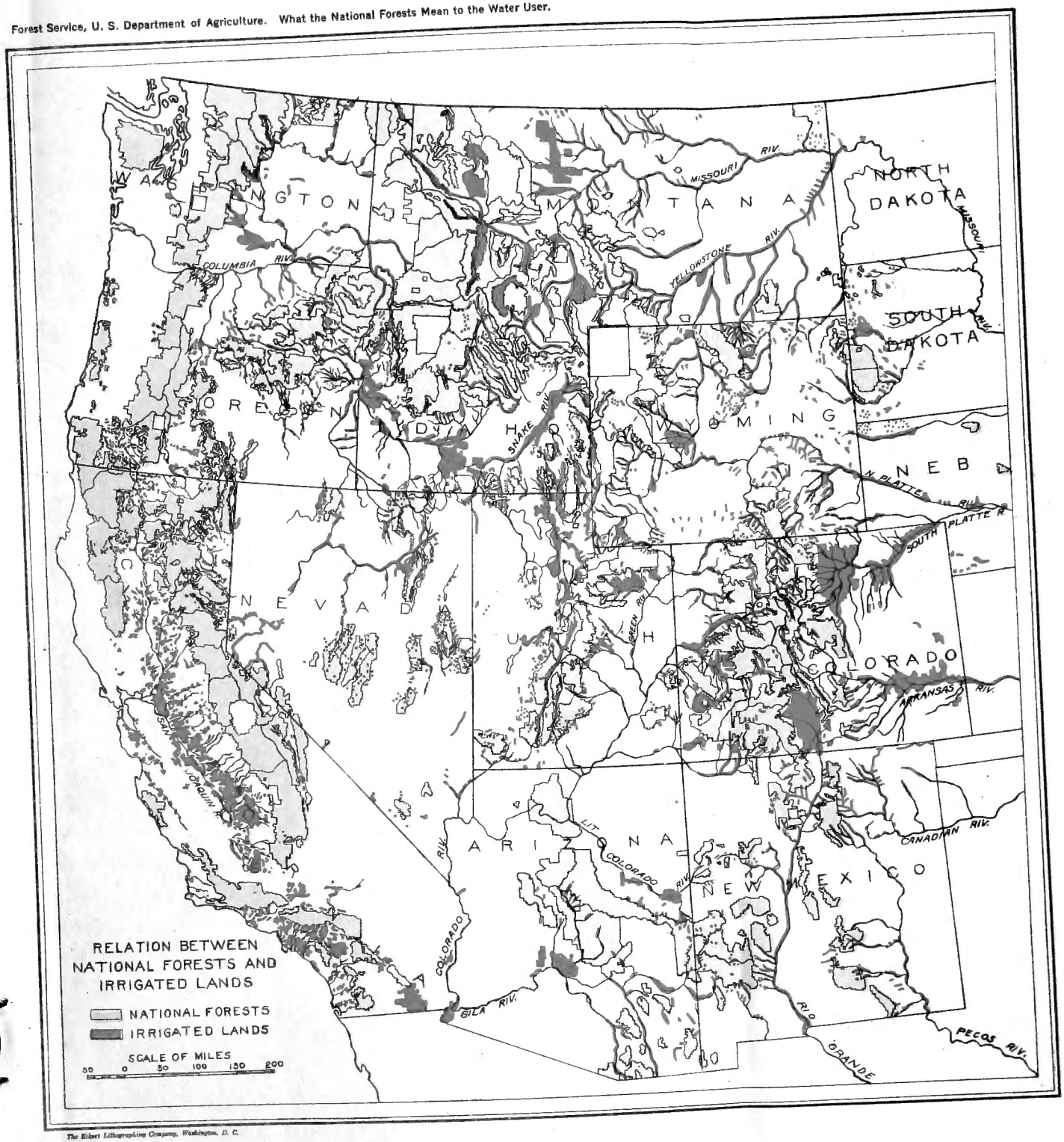
The result is that the majority of water users depend for their supply on water that originates a considerable distance away. Some of the most productive agricultural lands in the region receive hardly more than enough precipitation to support a desert vegetation, while the evaporation is correspondingly great. Greeley, Colo., Provo, Utah, Phoenix, Ariz., and Fresno and Riverside, Cal., all of which are in the center of extremely productive sections, have an annual precipitation of less than 15 inches with an annual evaporation from a free water surface at least three or four times as much.

As a natural consequence of the difference in amount of precipitation in the mountains and at the lower elevations, the former are generally forested and the latter treeless. The National Forests, of course, are located in the mountains, where the trees are. From the brush-covered foothills of the San Jacinto and San Bernardino Mountains in southern California to the magnificent Douglas fir forests of the Olympic Mountains in northern Washington, and from the piñon and juniper stands of the southern Rockies in New Mexico to the pine forests of the northern Rockies in Montana and Idaho, the mountains and the National Forests coincide.

The intimate relation that exists between the National Forests and irrigated lands throughout the West is shown on the map (fig. 1).[1] At least 85 per cent, and very likely more, of the water used to irrigate these

[1] The irrigated areas shown on this map are not always drawn exactly to scale; nor is the entire area shown as irrigated actually irrigated, any more than the entire area shown as National Forest land is actually owned by the Federal Government. To have attempted to show nonirrigated or privately owned lands within the exterior boundaries of irrigation projects or National Forests would have been impossible on a map of this scale.

Forest Service, U. S. Department of Agriculture. What the National Forests Mean to the Water User.



The Eckert Lithographing Company, Washington, D. C.

13,200,000 acres, whether it comes from surface streams and lakes or from underground sources, has its origin in the mountains where the National Forests are located. Obviously, not all of this mountain area is forested, nor is all of the forested area under Federal ownership. At the same time, the National Forests include a large part of the area from which the bulk of the irrigation water is derived, and must therefore exert an important influence on the amount and character of the supply.

No figures are available as to the exact value added to these lands by the application of water, but it unquestionably runs into the hundreds of millions of dollars. Without water much of this area would be practically worthless, and the value even of that portion on which dry farming is feasible would be greatly reduced. In the vicinity of Salt Lake City, Utah, for example, irrigated lands deriving their water from the Wasatch National Forest are valued at from $100 to $1,000 per acre, with an average of probably $400 per acre; while land without water in the same district, except where it requires drainage, is practically valueless. Near Los Angeles, Cal., unimproved lands with water rights are worth from $200 to $500 per acre, while bearing orange or lemon groves may be valued at $3,000 or even more per acre. What the water supply protected by the Angeles National Forest means to this region is also well illustrated by the value of the crops produced on irrigated lands that without water would be of little or no agricultural value. In 1915, 25,750 acres devoted to citrus fruits, alfalfa, and sugar beets, deriving their irrigation water from the San Antonio watershed, with an area of only 24 square miles, yielded crops valued at $5,400,000; while 5,870 acres of citrus fruits, deriving their water from the San Dimas watershed, with an area of only 18 square miles, yielded crops valued at $2,600,000.

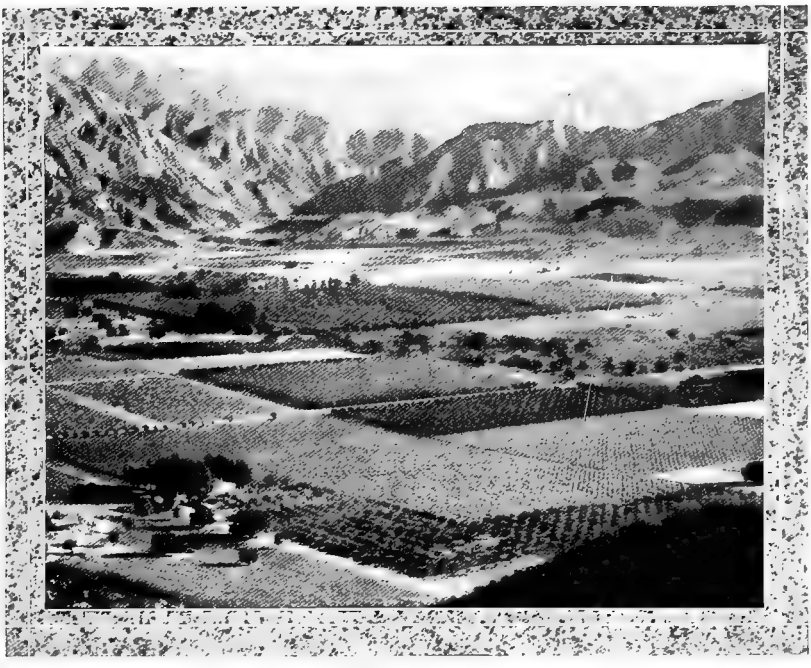
Irrigation represents one of the vital needs for water in the West, but there are others. Water is the "white coal" which furnishes or will furnish the motive power for lighting systems, trolley lines, and manufacturing plants everywhere in the Western States. As such it constitutes an immensely valuable resource. The western mountains contain more than 72 per cent of the potential water power of the United States. Through lack of markets, only a comparatively small part of this has been utilized, but in the last 20 years great strides have been made in development. In the decade from 1902 to 1912,

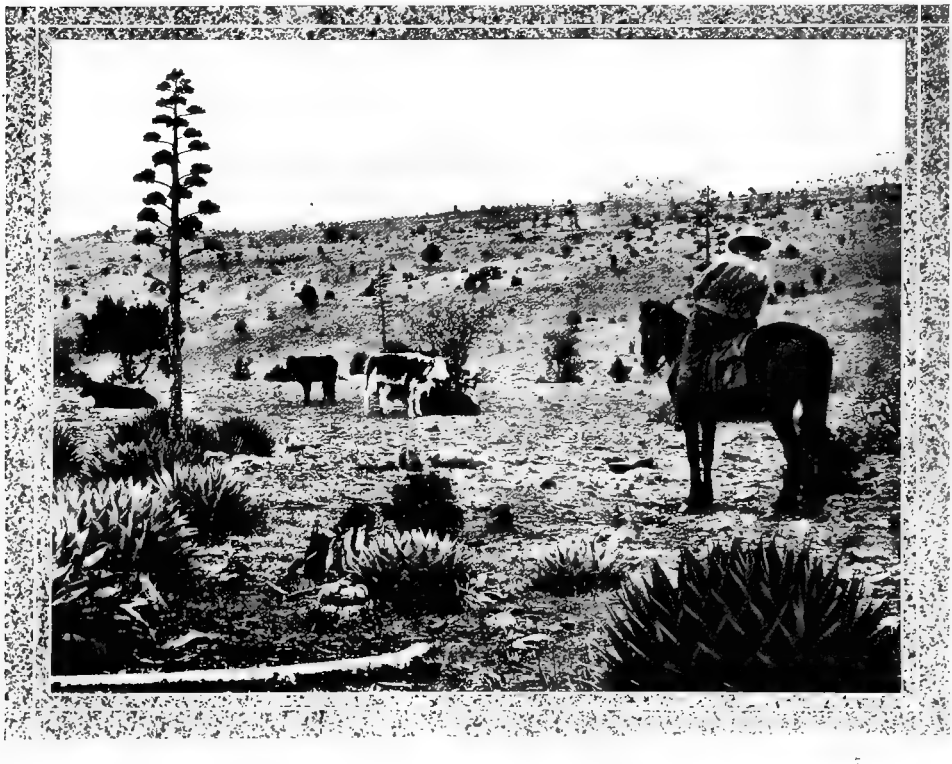
Power

What Water Will Do

Top.—With—where the oranges grow. The orange groves and other irrigated lands in the foreground obtain their water from the mountains in the background, which are included in the Angeles National Forest, Cal. At the lower elevations these mountains are covered with a dense growth of brush, or chaparral, while at the higher elevations are forests of western yellow pine, Jeffrey pine, and other trees. The value of citrus fruits produced in the eight southernmost counties of California in 1914 is estimated by the Los Angeles Chamber of Commerce to have been $33,000,000.

Bottom.—Without—where the agaves grow. Semi-desert land near Silver City, N. Mex., now used during part of the year as stock range. If irrigation were possible many of the desert areas throughout the West could be converted into fertile agricultural land. Water, rather than soil, is frequently the decisive factor in determining whether cultivation is practicable.





for example, water-power development in the Western States increased 451 per cent, or more than four times as rapidly as in the rest of the country. How rapidly water power is developed in the future will depend solely on how many new industries and people make their home in the West. Judged by how many have gone there in the past, the demands of the Western States upon their "white coal" will continue to multiply.

No less than 42 per cent of the water power resources of the 11 Western States, or approximately 31 per cent of the water-power resources of the entire country, is actually within the National Forests. Moreover, a large part of the remaining power, although developed outside of the Forests, is derived from streams rising in them. In 1915 nearly 42 per cent of the water power already installed was developed by plants some part of which occupied National Forest lands or which were directly dependent on storage reservoirs constructed on National Forest lands, and 13.6 per cent more was similarly dependent on other public lands. Even these figures, however, do not bring out the full significance of the National Forests in their relation to the water-power resources of the West. A large part of these resources outside of the Forests are so located as to be extremely difficult of development under present conditions, and so a continually increasing proportion of new water-power developments is utilizing sites within National Forests or other public lands.

Navigation

Farther downstream, in the lower reaches of the rivers and in the harbors into which they flow, water contributes still further to western prosperity. Inland water transportation in the Mountain and Pacific States will never attain the development of which it is capable in the Eastern and Central States, but it is already of considerable importance, and should become increasingly so as the population grows denser and traffic correspondingly heavier. According to the 1916 report of the Chief of Engineers, United States Army, there were at that time some 26 navigable streams in the Western States, with a navigable length of approximately 1,746 miles and an annual movement of over 14,000,000 tons valued at more than $250,000,000.

The relation of the National Forests to navigation is not strikingly obvious, since practically all the navigable portions of western streams lie outside of the Forest boundaries. Yet by far the greater part of the water that they carry originates in their upper courses, which are to a large extent

included within the National Forests. Any influence that the Forests may exert on this water is therefore felt indirectly, but none the less surely, by the streams and by the harbors into which they flow.

Ordinary drinking water may lack the romantic associations of some other beverages, but it nevertheless is an everyday necessity for thousands of families scattered on farms and ranches and in numerous small settlements throughout the West and for the still larger population comprised in the towns and cities. How much effort and money must be expended by western cities in obtaining a pure and abundant water supply is shown by the examples of Los Angeles and San Francisco, the first of which has considered it worth while to spend some $25,000,000 to bring water from Owens Valley on the east side of the Sierras across 250 miles of desolate and rugged country; while San Francisco is going back 190 miles into the fastnesses of the Sierras at an estimated cost of $77,000,000 in order to get its supply from the famous valley of the Hetch Hetchy.

Domestic Supply

Some 732 western towns and cities, with an aggregate population of 2,265,000, depend on the National Forests for their domestic water supply. This does not include, of course, ranches and small settlements equally dependent on the Forests, nor the towns and cities securing their domestic water from streams and underground supplies which are at some distance from the Forests, but which rise from sources within them. Denver, Colo., Salt Lake City, Utah, Los Angeles, Cal., and Portland, Oreg., are conspicuous examples of large cities which are insured a pure and abundant water supply by the National Forests. So important is this function of the Forests that many communities have entered into cooperative agreements with the Forest Service for the better protection of the watersheds from which they get their supplies.

Beneficial Effects of Forest Cover

Perhaps the most obvious relation that exists between forests and water is the tendency of the tree cover to check erosion. The leaves and branches of the trees prevent the rain from beating upon the soil as it does in the open; the cover which they afford delays the melting of snow in the spring; the upper layers of the forest soil act as an enormous sponge that absorbs

Checking Erosion

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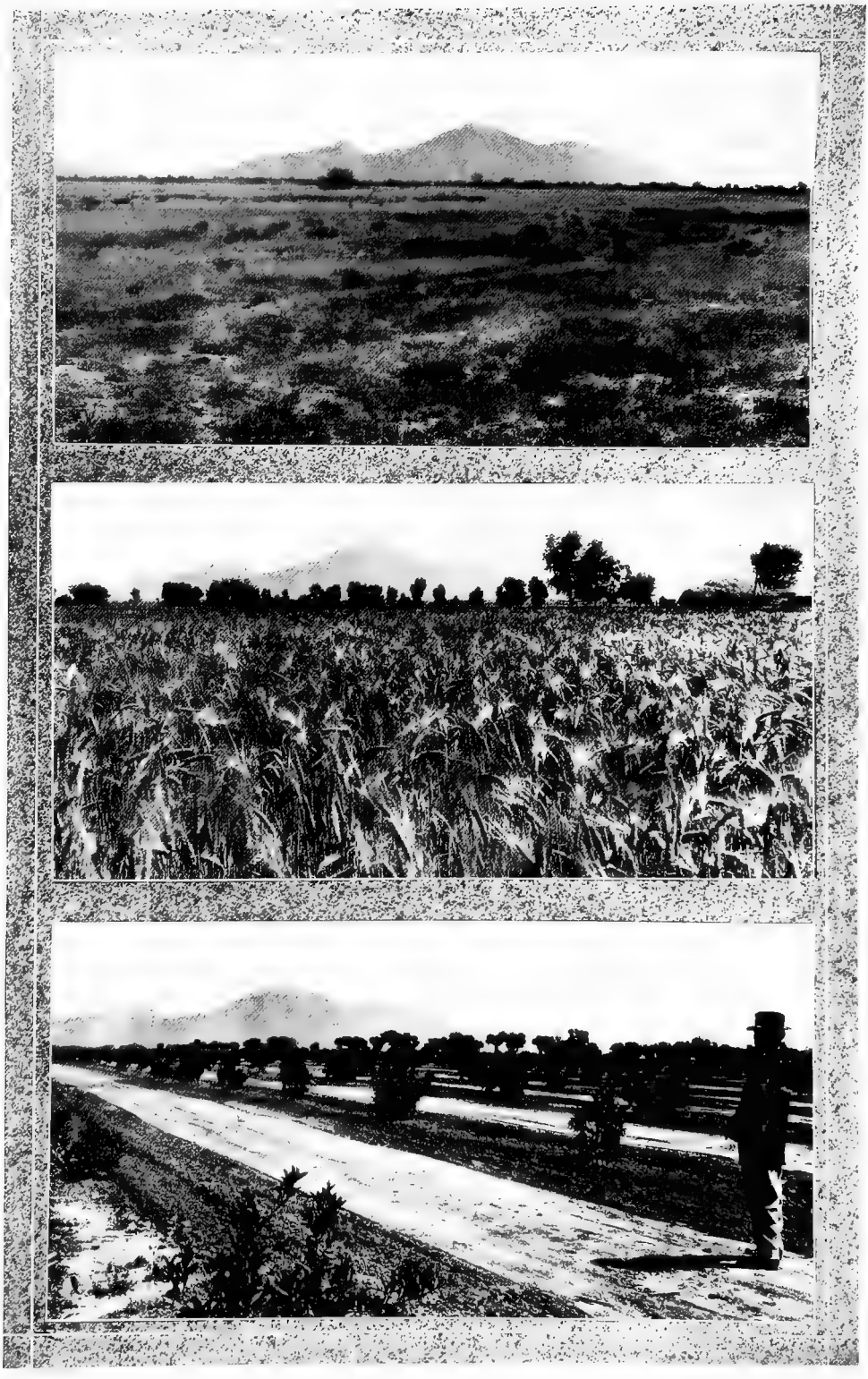
Irrigation Reservoirs on the National Forests

Top.—Lake Keechelus on the Wenatchee National Forest, Wash., used as one of the storage reservoirs for the Yakima Reclamation Project. When completed, this project will include more than 146,000 acres of irrigated land. The crop production in 1915, on about two-thirds of the area ultimately irrigable, was valued at $2,400,000.

Middle.—Granby Lakes on the Battlement National Forest, Colo. This Forest was created in 1892 at the request of local residents to protect their supply of water for irrigation and domestic use. Within its boundaries are now some 400 reservoirs supplying about 140,000 acres of irrigated land valued at more than $2,500,000.

Bottom.—Jackson Lake on the Teton National Forest, Wyo., with the Teton Mountains in the background. This forms one of the main storage reservoirs for the Minidoka Reclamation Project.



Before and After

Top.—A portion of the Salt River Reclamation Project in southern Arizona previous to irrigation, covered only with a sparse growth of desert vegetation.

Middle.—The same area after water has been applied, covered with a vigorous crop of barley.

Bottom.—The same area several years later, covered with a thrifty young orange grove.

large quantities of water which in turn are passed on to the great reservoir of mineral soil beneath; and finally, the surface cover of stumps, fallen twigs, branches, and even whole trees acts as a mechanical obstruction to prevent rapid run-off. The surface run-off from forest areas is less, both in total amount and in velocity, than that from similarly situated unforested areas. The steeper and more rugged the topography, the more marked is this contrast.

In hilly country some erosion is, of course, inevitable under any conditions. When the soil cover of trees, underbrush, and litter is kept intact, however, this is more often beneficial than otherwise, since only the lighter soil particles are washed away, to be later deposited in the more level lands below, adding to their fertility. But when this protective cover is interfered with, whether by fire, destructive lumbering, overgrazing, or injudicious clearing of land for agriculture, the proportion of coarser, infertile materials washed away increases greatly and transforms erosion from a constructive into a dangerously destructive force, difficult of control and capable of doing untold damage.

From the standpoint of the water user, the tendency of the mountain forests to prevent erosion is of the utmost importance. Wherever storage reservoirs must be used, whether for municipal supplies, irrigation, or water power, they are exposed to the ever-present danger of silting up. Every bit of soil brought down by the streams and deposited in them reduces their capacity and consequently their effectiveness by just so much. This sedimentation is serious under any condition, but doubly so when, as not infrequently happens, no other satisfactory dam sites are available and the reservoir can not be replaced at a reasonable cost.

Water heavily laden with eroded material often decreases the efficiency and increases the cost of maintaining diversion dams, pipe lines, flumes, canals, and other irrigation works. Sometimes such water damages the crops to which it is applied, and not infrequently it seriously injures or even ruins the land by burying it under a mass of sand, gravel, bowlders, and other infertile débris. Excessive erosion may interfere seriously with navigation by filling the streams with material which is deposited in their lower reaches and in the harbors into which they empty.

The action of the forest in reducing surface run-off tends also to regulate the flow of streams. Instead of rushing away in uncontrollable tor-

rents the water is absorbed into the great reservoir of mineral soil, from which it is gradually paid out to the springs and streams. This tends to decrease the high water run-off and to increase the low water run-off. Both results are good. The decrease in the high water run-off means that there is less danger of destructive floods and less waste of valuable water; while the increase in low water run-off means that a larger supply of water is available during the dry season, when it is particularly needed. It is the low water flow that to a great extent determines the availability of any given supply for municipal use, irrigation, or hydroelectric development, and anything which will increase this flow is therefore a factor of prime importance.

Regulating Stream Flow

What One National Forest Does

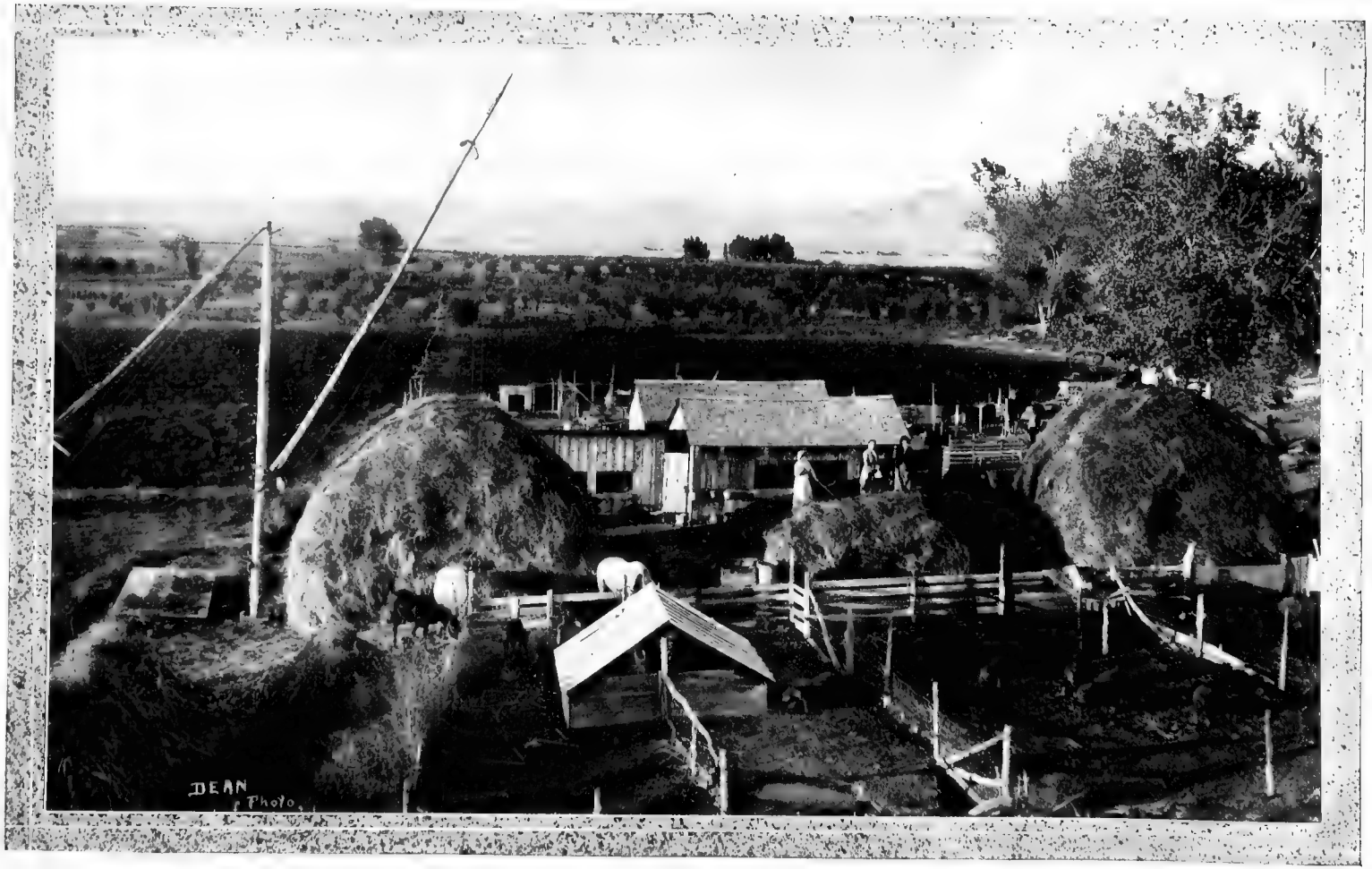
A typical example of the ways in which the National Forests benefit the water user is furnished by the Pike National Forest in Colorado. This Forest extends along the main range of the Rocky Mountains from somewhat north of Denver to south of Colorado Springs, and includes within its boundaries a considerable portion of the headwaters of the South Platte and Arkansas Rivers.

Irrigation by means of water coming from the mountains included in the Pike National Forest had its modest beginnings in 1860 along the South Platte River in South Park and also near Denver. Since then the area on which irrigation is practiced has grown steadily, until now it is estimated at some 400,000 acres, valued at about $40,000,000 and with an annual crop production of over $10,000,000. On many acres where water is not available dry farming is practiced, but the results are uncertain and the yields much less than on irrigated land. The value of water in this region is so great that the natural flow of the streams is greatly overappropriated, and there is need for every additional drop that can be developed or stored. Practically all of the Great Plains lying east of the Rocky Mountains is potentially agricultural land, and the only limit to its development is the amount of water which can be secured for irrigation. So well recognized is the part played by the forest cover in protecting the water supply that in one case an organization of farmers has protested against any cutting of timber on certain watersheds.

The Desert Blooms

Top.—With and without—a striking illustration of the transformation worked by the application of water. The dry land outside of the fence on the Minidoka Reclamation Project is a sagebrush desert; that inside, a fertile field of alfalfa. The water used on this project comes in large part from the National Forests at the headwaters of the Snake River.

Bottom.—An apple orchard on the Boise Project of the Reclamation Service in western Idaho on land formerly covered with sagebrush. This project is able to furnish water for the irrigation of 230,000 acres, includes a population of 47,000, and in 1915 produced crops valued at $2,327,400. A considerable part of the water supply for the project is protected by the Boise and Payette National Forests.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Irrigation Means Prosperous Homes

An irrigated ranch near Grand Junction, Colo. Similarly situated lands in this region without water are practically valueless. The water for irrigation originates mainly in the Rocky Mountains, where it is protected by the Uncompahgre, Gunnison, Battlement, and other National Forests.

No less important is the use of the water for domestic and municipal purposes. Denver has its main storage reservoir, Lake Cheesman, with a capacity of about 26,000,000,000 gallons and a watershed of 1,152,000 acres, in the heart of the Pike Forest. Colorado Springs has a series of reservoirs which also get their supply from the Pike. Altogether, some 35 cities and towns with an aggregate population of 275,000, and an investment in waterworks of over $17,600,000, obtain their domestic supply from this Forest. The watersheds supplying Denver, Colorado Springs, Manitou, Cascade, and Idaho Springs are given special protection against fire. At the request of local residents, Congress has added nearly 28,000 acres to the Pike Forest, while farther north, on the Colorado National Forest, Congress in 1916 authorized the addition of some 540,000 acres for the purpose of watershed protection.

Where fire has destroyed the forest cover on certain of the watersheds within the Pike, young trees are being planted. Already some 3,000 acres have been planted by the Forest Service on the watersheds denuded by the great fire of 1866, from which Colorado Springs and its suburbs obtain their water, and plans have been perfected for the reforestation of an additional 9,000 acres.

The development of hydroelectric power bids fair to constitute another important use of the streams which take their rise in the Pike National Forest. It is only in recent years that water in this region has been utilized for power, but the possibilities for development offered by the streams are tremendous.

Placer mining, which, aside from drinking and bathing, probably called for the first use of water on the Pike National Forest, is now practically a thing of the past. The use of water in the milling of ores, however, is quite common in a number of districts, and there are many mills which could not operate without an abundant and constant supply.

The value of water as a scenic, or esthetic, asset, and its contribution to recreation in the region, should also not be overlooked. To the Pikes Peak region come thousands of visitors every year, attracted by the scenery and climate. Periodically dry streams and eroded stream beds are far from attractive, and in helping to prevent erosion and to maintain a steady stream flow the forest adds materially to the value of the region for the tourist and pleasure seeker.

Some Results of Forest Destruction

How any interference with the protective cover of trees and other vegetation works to the detriment of the water user is illustrated by the history of a small stream on the Pike Forest known as Trail Creek. This was originally a clear stream confined to a narrow channel and with comparatively little erosion. Gradually, however, the character of the stream changed as a result of heavy cutting on its watershed, prior to the creation of the National Forest and on private lands included within the Forest boundaries, followed by a number of severe forest fires. Floods became more frequent, erosion set in, the stream beds were widened, and their bottoms began to fill up with sand and gravel washed down from above.

Trail Creek

In April, 1914, a heavy flood occurred which wrought serious damage to a small ranch at the mouth of the creek. Approximately 11 acres of irrigated land, worth $40 an acre and including nearly a fourth of the irrigated land on the ranch, were buried under from 18 to 30 inches of coarse gravel and rendered practically worthless. Furthermore, the flood filled up the irrigating ditches so completely and changed the course of Trail Creek so markedly as to make it impossible to continue the use of water from the creek for irrigation without going to considerable expense in the construction of new improvements. In August of the next year a heavy hailstorm resulted in another flood which washed out several acres of hay land along the creek bottom and ruined 16 tons or more of hay worth $14 a ton. The same storm also brought down an immense amount of gravel in an ordinarily dry gulch running through the farm and piled this 2½ feet deep against the kitchen door. Altogether, the floods of these two years damaged this one small ranch to the extent of at least $600 and rendered approximately one-fourth of it practically nonproductive.

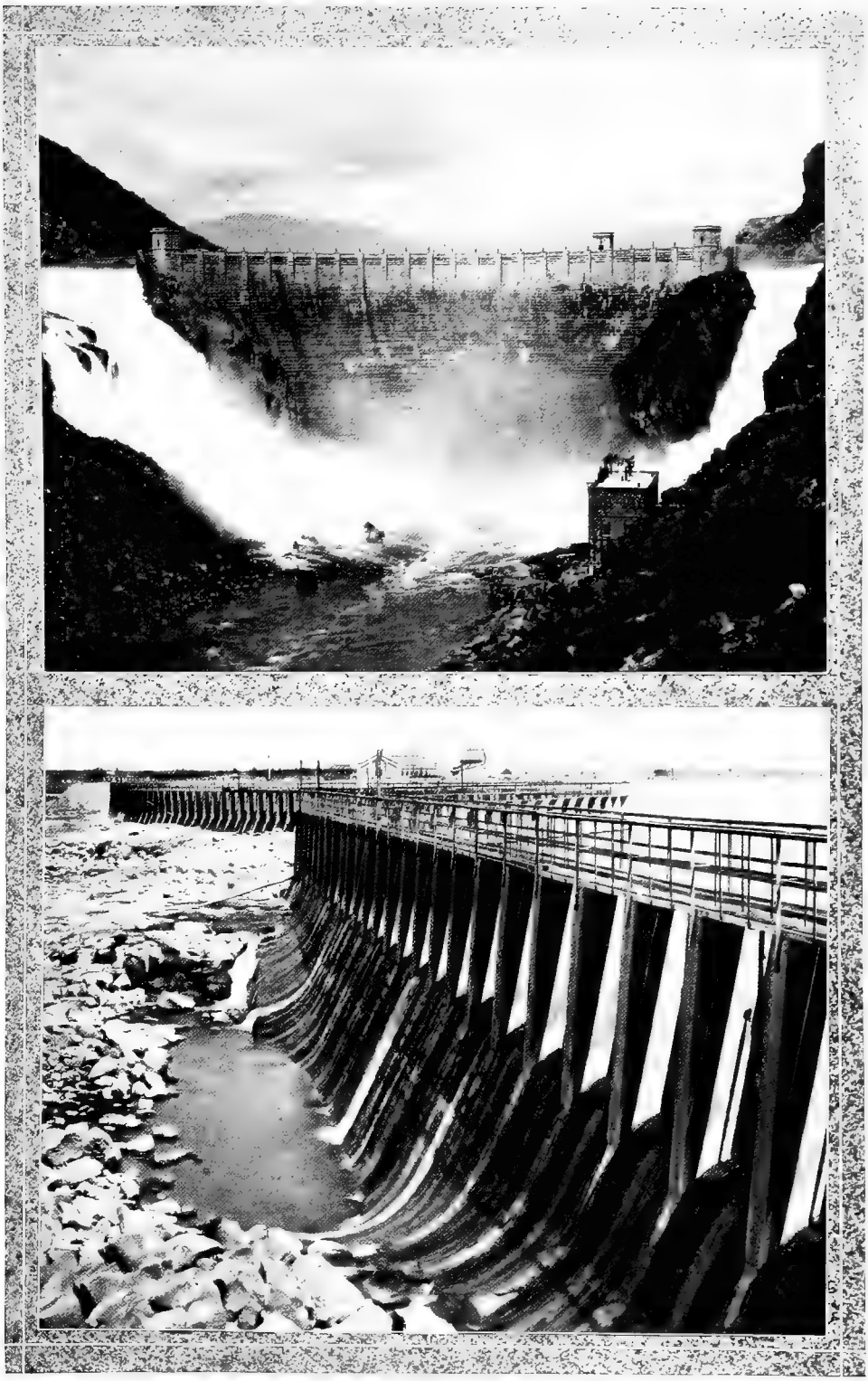
Other examples of the damage resulting from interference with the forest cover before the creation of the National Forests can be selected almost at random from the Mountain Forests of the West. In the Sangre de Cristo Range and the Greenhorn Range, in what is now the San Isabel National Forest, in southern Colorado, it is very noticeable that streams whose headwaters have been denuded to a considerable extent of their protective cover have badly eroded channels and are subject to great extremes in

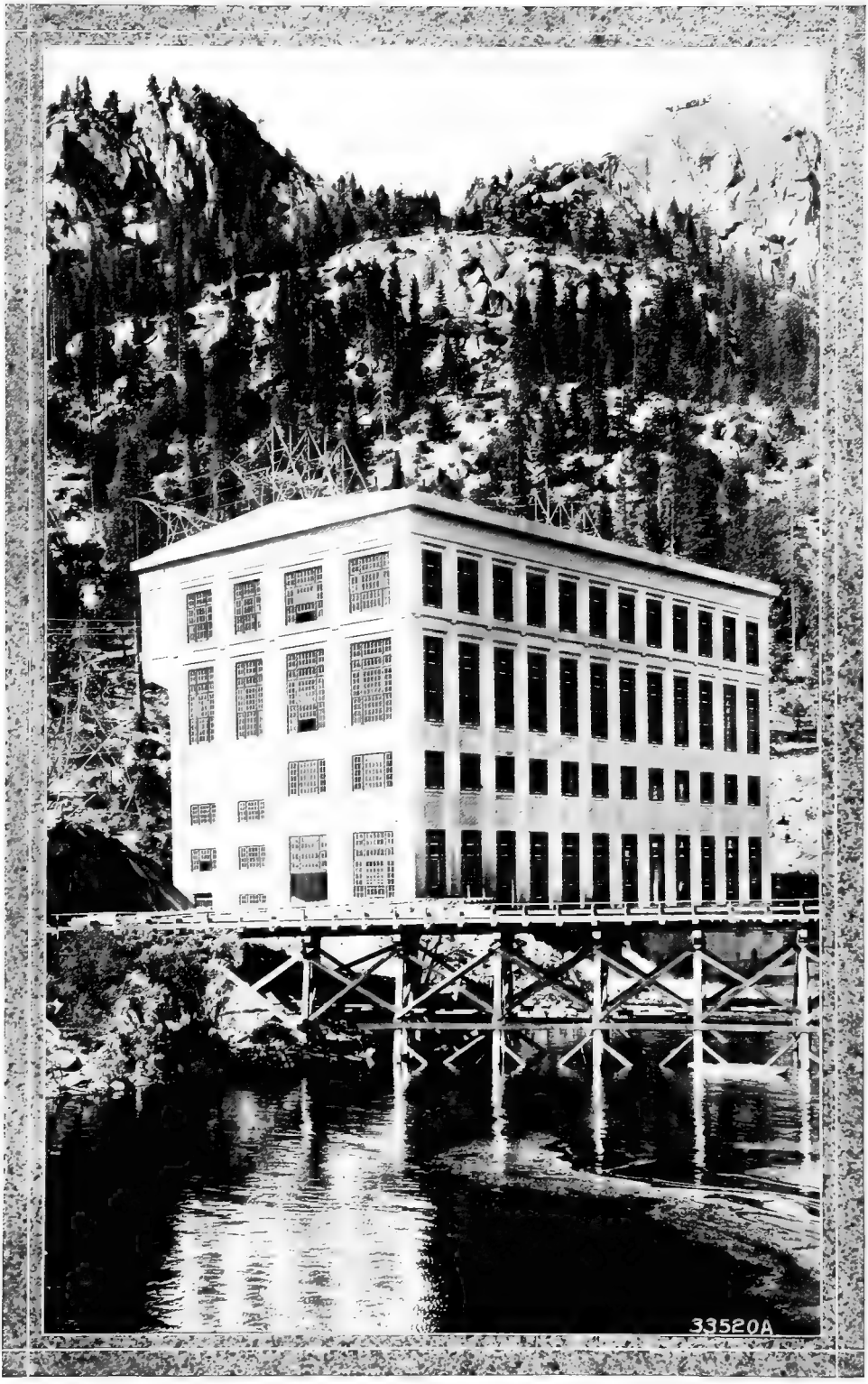
San Isabel Forest

Water for Irrigation and Power

Top.—Roosevelt Dam and power plant (in right center foreground). This reservoir stores 1,140,000 acre-feet of water and, together with the Verde River, furnishes the water supply for the Salt River Reclamation Project in southern Arizona. This project includes 189,000 acres of irrigated land supporting a population of 53,000 and with a crop production for the year 1917 of $14,750,000. The bulk of the water for the project originates on the Tonto National Forest and the White River Indian Reservation.

Bottom.—Minidoka Dam and power plant. This dam supplies water for the irrigation of 120,300 acres on the Minidoka Reclamation Project in southern Idaho. The electricity developed at the power plant is used on many farms for lighting, heating, and cooking.

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Where "White Coal" is Transformed into Electricity

A power plant on the Sierra National Forest, Cal. The pipe line has a drop of 2,000 feet. The National Forests contain 42 per cent of the water power resources of the West. These can be developed by private interests upon payment of an annual charge and under restrictions that protect the public against monopoly.

flow, with frequent destructive floods, while no harmful effects of this sort are noticeable on streams whose headwaters are well timbered. Wild Cherry Creek, for example, after being almost completely burnt over, was subject to spring floods and to damage from erosion. During July it would dry up at a distance of not over 2 miles from the mouth of the canyon. As the watershed has become reforested these conditions have changed gradually until to-day the stream is not subject to floods and erosion and is more regular in its flow. During the summer it now reaches a point 4 miles below the mouth of the canyon and is used early in the fall for irrigation. Apache Creek, which formerly flowed the full length of its course all summer, since the destruction of the timber at its headwaters disappears only 2 or 3 miles from its head; and its only value for irrigation purposes after the middle of June lies in its flood waters, which are very uncertain. Hardscrabble and Medano Creeks have suffered similar results, and the list might be extended almost indefinitely.

Gunnison River

On the North Fork of the Gunnison River, in western Colorado, much flood damage has occurred as a result of the extensive fires which burned over its upper watersheds in the late seventies and early eighties. Previous to that time the creek channels were narrow and rocky, beavers were abundant, and the bottom lands showed little erosion. In 1884 a heavy snowfall was followed by a flood which is estimated to have ruined at least 2,000 acres of good ranch land. Since then destructive floods have occurred every few years. In 1912 irrigated land and other property was damaged to the extent of some $20,000, a $5,000 bridge was washed out, and $8,000 was expended in preventing the destruction of two other bridges. In spite of this comparatively recent damage it is generally believed that floods are becoming less frequent and less destructive as adequate fire protection on the Gunnison Forest is gradually restoring a forest cover on the burned-over areas.

Gypsum Creek

Thirty years ago a big fire burned over the watershed of Gypsum Creek, which is located in central Colorado in what is now the Holy Cross National Forest. Two years after this fire the low water flow of the creek was so reduced that the use of water for irrigation from it was restricted to the first 47 decrees. Since then the flow had gradually increased with the establishment of a

dense stand of timber until now it furnishes sufficient water for 130 decrees.

Bighorn Forest

The following letter from a rancher in northern Wyoming throws light on what the protection afforded by the Bighorn National Forest means to the water user in that part of the country: "I have resided on Rock Creek for 28 years. During all this time I was owner of a ranch and was dependent on a good supply of water for all my crops; the welfare of my stock and my own financial standing depended, therefore, more or less, on a good flow of water in Rock Creek. All these reasons make a man observant and thoughtful about any causes that may prevent a normal flow of water in any stream the headwaters of which are in the mountains. We all know that if a forest fire runs through the biggest portion of the watershed of a stream the water supply of such a stream is greatly diminished, if not entirely cut off, during the latter part of July and August, and untold damage is done to all ranchmen who are dependent on such a burned-off area for their irrigation water.

"As proof of the foregoing, I mention the great fire on the headwaters of Rock Creek in 1890, when four-fifths of the Rock Creek watershed was burned off. There was good reason to think that it was incendiarism. Immediately after the fire and for eight years afterwards there was very little water at the right time. There were some destructive floods too early in the season to do the irrigator much good. But as the hills became covered with young reproduction the flow of Rock Creek kept increasing and the floods became less destructive, and to-day, 20 years after the fire, Rock Creek is nearly normal again, but not quite, for the reason that in the head of the main fork the fire was so destructive that there were no seed trees left for a distance of nearly 5 miles on the south side of the creek, and consequently the reproduction is very scattering.

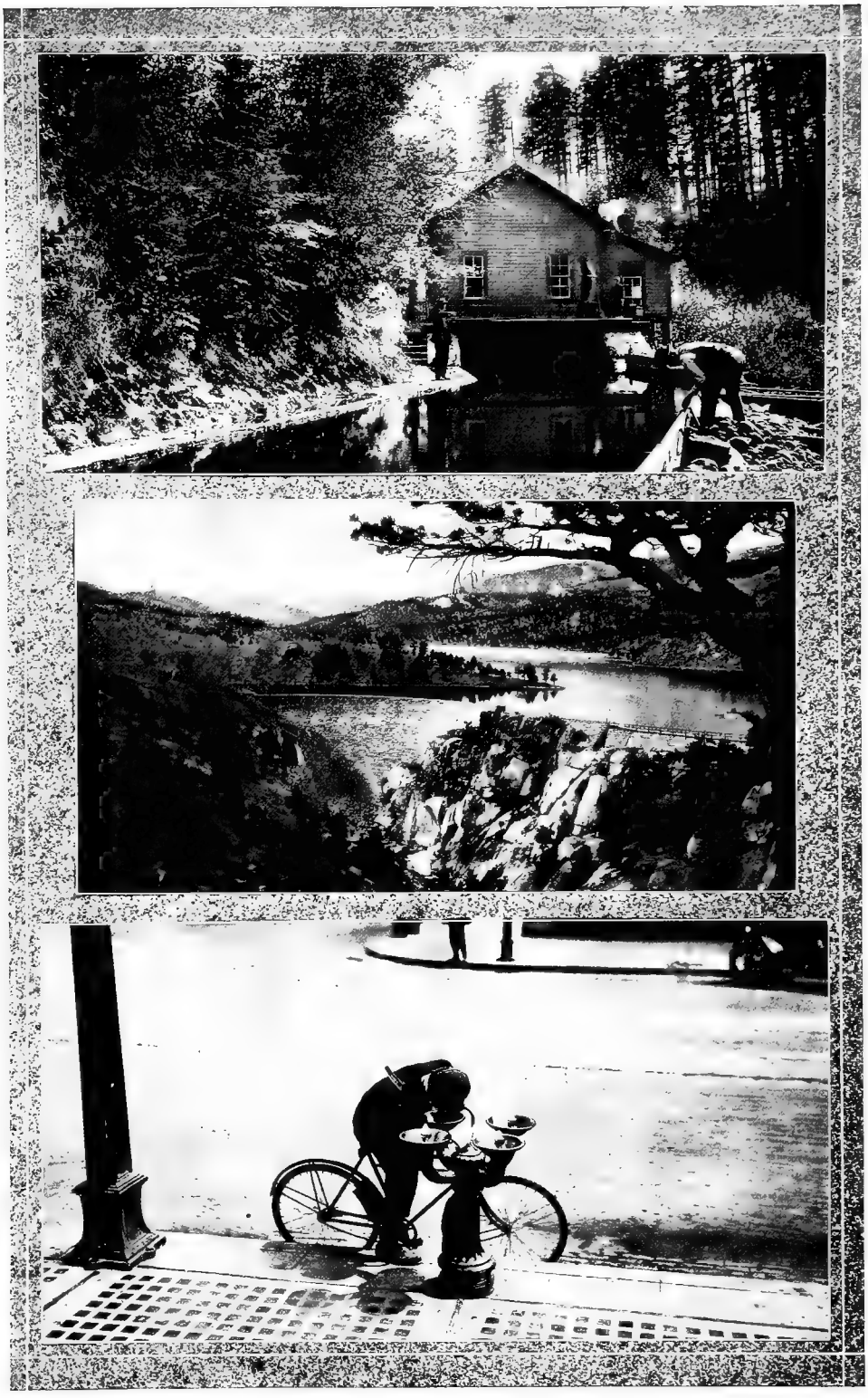
"In conclusion I wish to state that anyone who successfully farms a ranch in this part of Wyoming understands the great importance of keeping the forest fires out of the mountains and of maintaining a good stand of timber on the watersheds of all streams to hold the snow and help prevent the rapid run-off of the water too early in the season to be of much use to the irrigator."

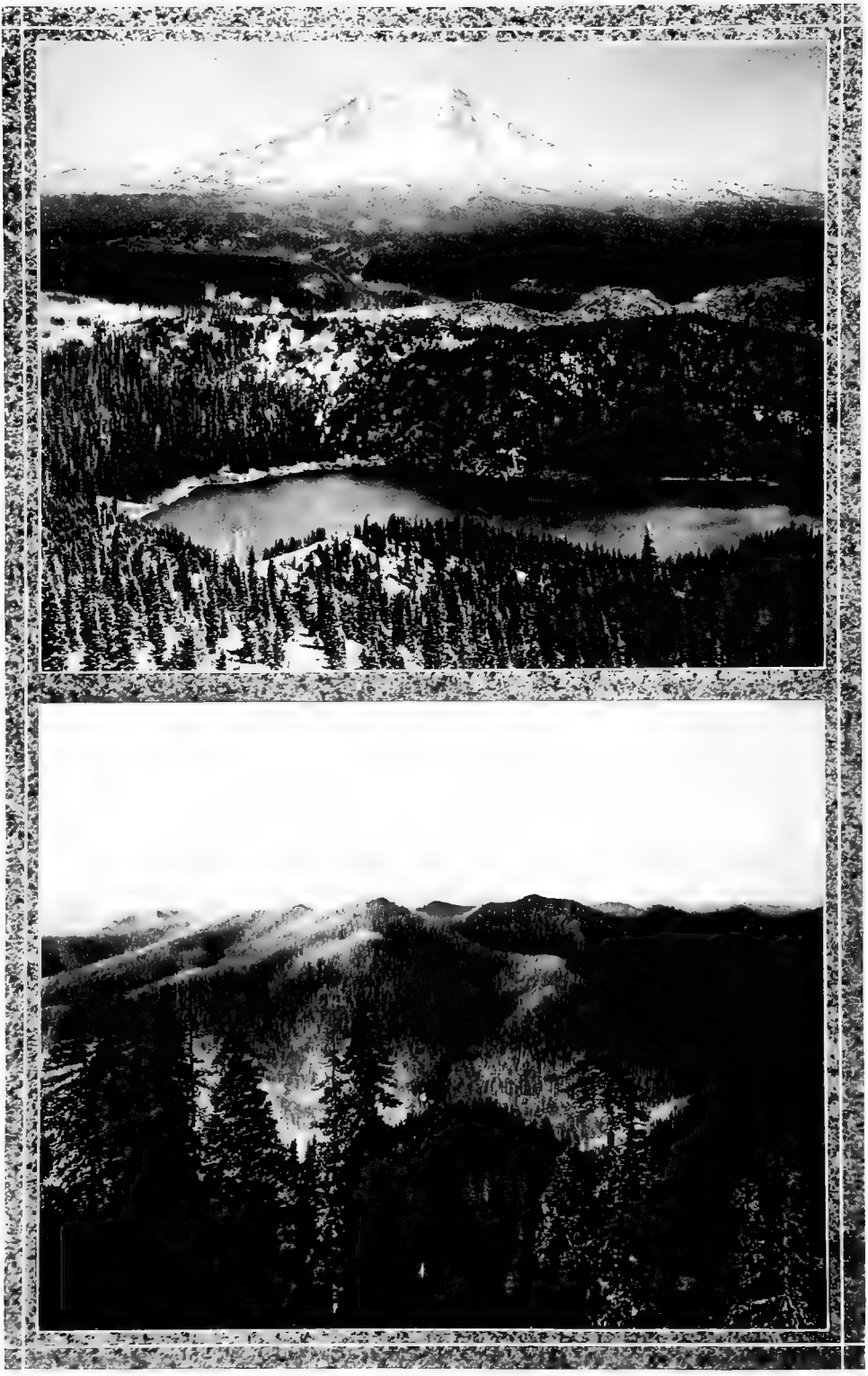
How the National Forests Protect Domestic Water Supplies

Top.—Intake of the water system for the city of Portland, Oreg. The water for the city comes from the Bull Run Watershed, which is entirely within and protected by the Oregon National Forest, under a special cooperative agreement between the city and the Forest Service.

Middle.—Lake Cheesman, in the heart of the Pike National Forest, Colo. This lake, with a storage capacity of about 26,000,000,000 gallons, forms the main reservoir for the water-supply system for the city of Denver.

Bottom.—Street drinking fountain in Portland, Oreg. The water comes directly from the Oregon National Forest, which insures both its purity and abundance.





Everywhere the National Forests and the Mountains Coincide

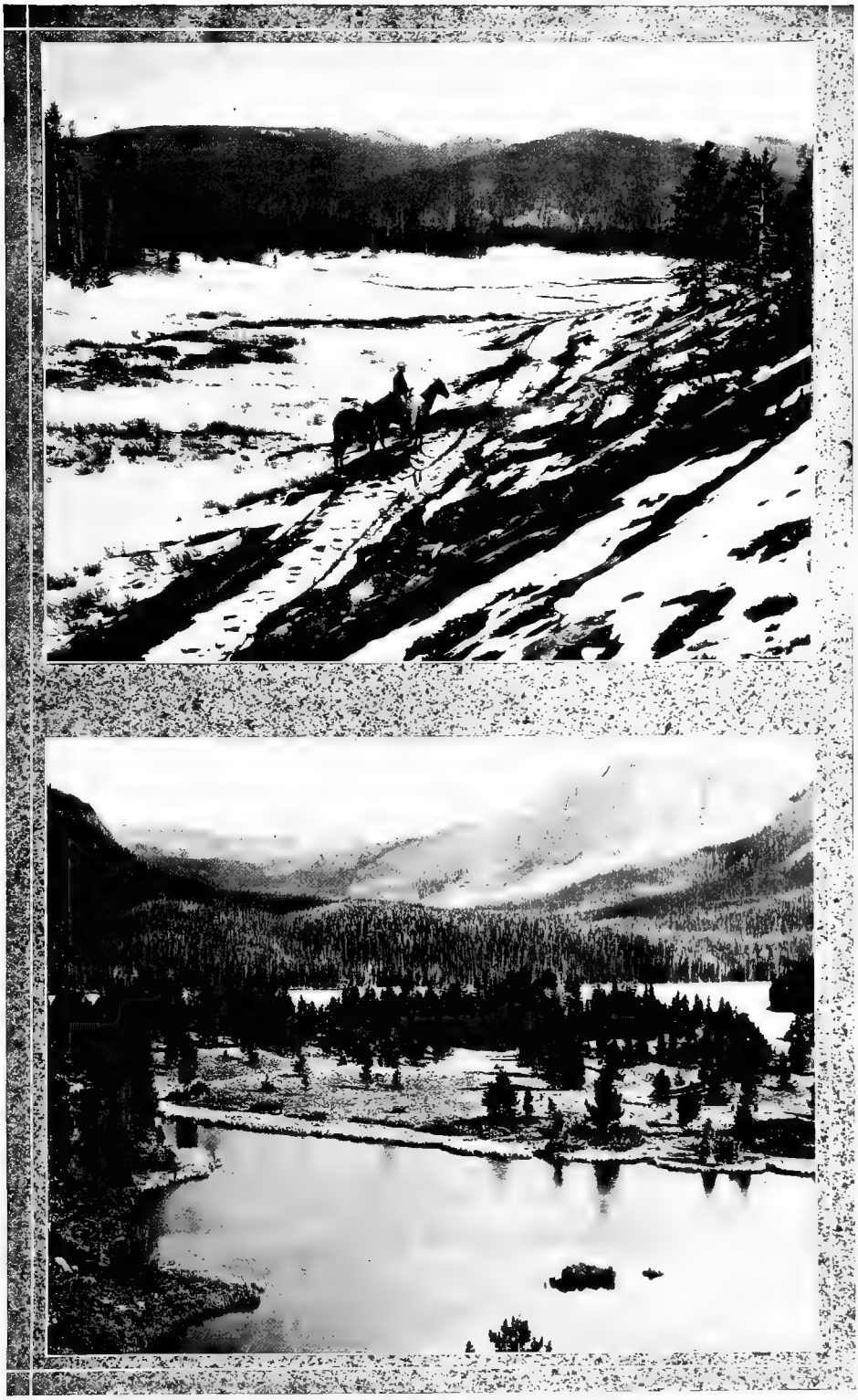
Top.—Headwaters of Lewis River in the Rainier National Forest, Wash., with Council Lake in foreground and Mount Adams in background.

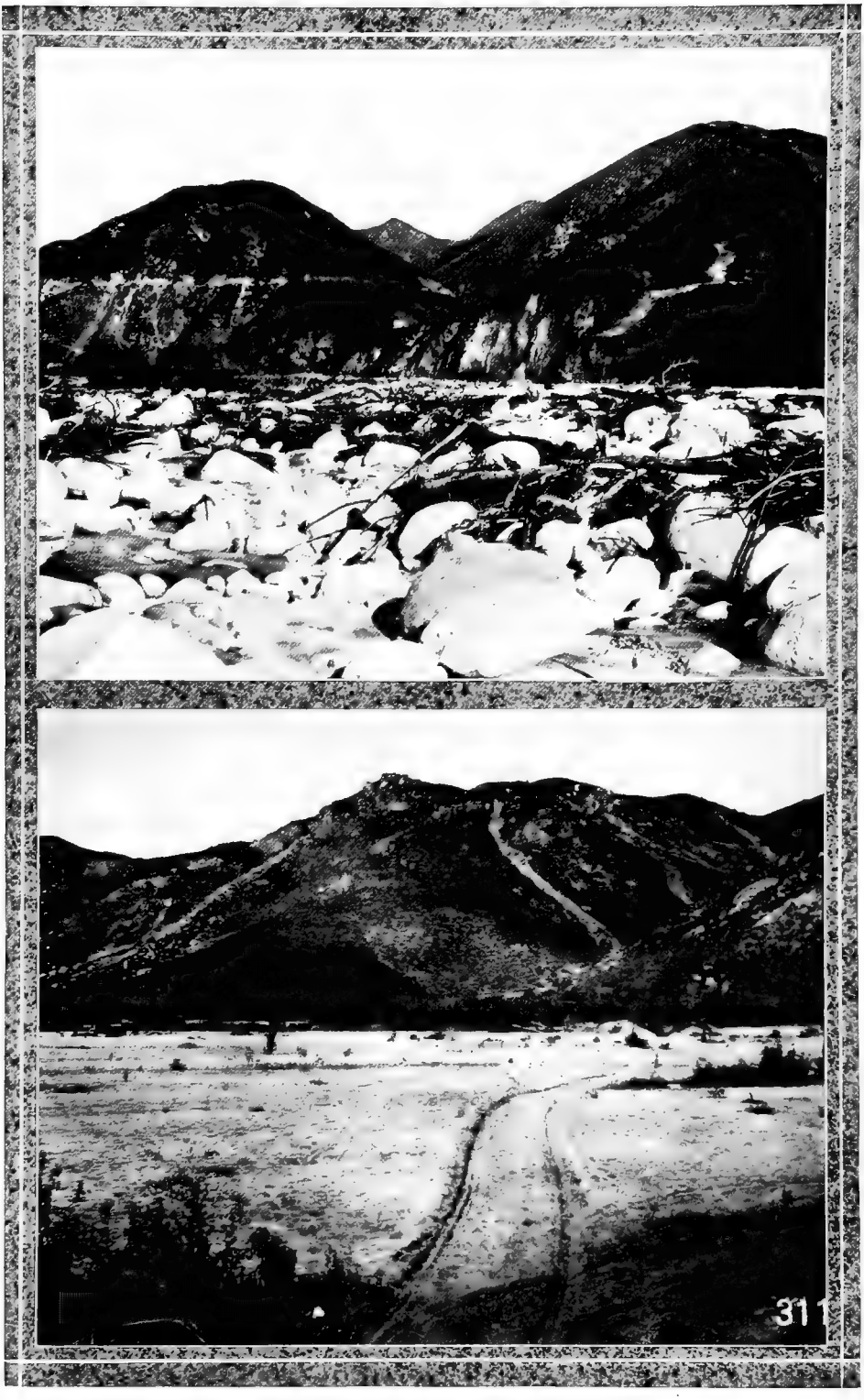
Bottom.—Typical view of the Cascade Mountains in the Columbia National Forest, Wash., with Mount St. Helens in background.

How the National Forests Protect River Sources

Top.—Willow Creek, one of the sources of the Colorado River, in the Arapaho National Forest, Colo. The stream comes gently from the belt of forest which stores melting snow from above timber line on the Parkview Peaks.

Bottom.—Trapper's Lake, also on the headwaters of the Colorado River, in the White River National Forest, Colo. The dense stands of timber which are characteristic of such situations help to prevent erosion and irregular run-off.

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What too Rapid Run-off Can Do

Top.—Bowlders for soil. This view of the Santa Ana River in southern California shows how torrential run-off may wash away the soil and leave the land covered with snags, gravel, bowlders, and other infertile débris. The irregular strip of cleared land winding up the brush-covered slopes in the background at the right forms part of a system of fire lines on the Angeles National Forest constructed to prevent the spread of forest fires.

Bottom.—Sand for alfalfa. The sand waste in the foreground is typical of hundreds of acres of formerly good alfalfa land along the San Diego River in southern California which were seriously damaged by the flood of January, 1916. As a result of this flood, which came largely from burned-over areas in the Cleveland National Forest, the stream in many places changed its course, considerably enlarged its channel, and injured adjacent agricultural lands both by washing them away and by burying them under sand and other infertile material. The slides on the sparsely covered hills in the background are most numerous where fires considerably reduced the protective cover of brush.

Many examples of destructive floods caused by overgrazing in the mountains prior to the creation of the National Forests are furnished by the State of Utah. In what is now the Fillmore National Forest the Chalk Creek, Pine Creek, Meadow Creek, Fool Creek, Oak Creek, and Scipio watersheds, which supply the water for 27,000 acres of irrigated land and for the towns of Fillmore, Meadow, Oak City, and Scipio, were at one time so heavily overgrazed that the resulting floods damaged roads, reservoirs, cultivated land, and other property to the extent of thousands of dollars. Since the creation of the National Forest grazing on these watersheds has been prohibited or restricted, and the vegetative cover has had a chance to reestablish itself. As a result, the floods have been steadily decreasing, both in number and severity, until they are now practically negligible. The importance of the protection exercised by this Forest is still further emphasized by the fact that, together with the Fishlake and Sevier National Forests, it is the source of water used in the irrigation of some 200,000 acres, valued at over $18,000,000, and as the domestic supply for some 28 towns, with a total population of about 13,000.

Utah

How National Forest Administration Benefits the Water User

In the actual management of the National Forests every precaution is taken to see that the interests of the water user are fully protected. No utilization of their various resources is permitted unless a negative answer can be given to the question, Will the proposed use have any injurious effect on the water supply?

An outstanding feature of National Forest administration is the emphasis placed on fire protection. Fire is the worst thing that can happen in a forest, both as regards destruction of property and interference with the water supply. Every fire, no matter how small, destroys some of the organic material in the surface layers of the soil, and to that extent reduces its absorptive capacity. Repeated fires on the same area, even if they do not destroy the forest outright, may practically nullify its effects in preventing erosion and regulating stream flow.

Fire Protection

Every effort is made to control so dangerous a menace. The guiding idea is to prevent fires from starting and to put out those that do start

before they attain any considerable headway. Various means are used to bring home to the general public the seriousness of the fire danger and to secure the cooperation both of local residents and transient visitors. Lookout stations are established on mountain tops and at other points of vantage for the prompt detection of fires. These are supplemented by riding patrols. Boxes of fire-fighting tools are placed at strategic points. Roads, trails, and telephone lines are built as means of quick communication. Extra men to serve as fire guards are appointed during the danger season, and the local community is so organized as to make an efficient fire-fighting force available on short notice.

The system has now reached a stage of efficiency where the majority of fires are brought under control before they do any serious damage. In 1916, for example, 73 per cent of the 5,655 fires on the National Forests were extinguished before they had burned over 10 acres, and only 4.4 per cent caused a damage of more than $100. The chief opportunities for further progress lie in reducing the number of fires that occur, and in this work every citizen can help. The water user in particular should be among the very first to cooperate in keeping down fires. His prosperity is intimately bound up with their suppression.

Necessary precautions are likewise taken to keep in check insects and diseases which would endanger the forest cover on watersheds in the National Forests.

Land Classification

When the boundaries of the National Forests were first drawn it was inevitable that occasional areas of land more suitable for farming than for timber production or watershed protection should have been included. To make certain that all of the lands within the National Forests will be put to their best use thorough surveys were made by experts, as a result of which the lands have been classified according to their primary value for timber production, watershed protection, agriculture, and the like.

In making this classification, one fundamental principle was followed, namely, that land chiefly valuable for the prevention of erosion or the regulation of stream flow should be retained in the National Forests and administered primarily for these purposes. Such other lands as appear to be more valuable for crop production have either been eliminated altogether from the National Forests or else opened to entry under the Forest Homestead

The Fire Menace

Top.—Vista Point, on the Santa Fe National Forest, at the headwaters of the Pecos River. Dense stands of timber are typical of the higher elevations, where fire has been kept out, and form an ideal cover for the watersheds.

Bottom.—View on the Rainier National Forest, Wash., along Stabler Ridge and Niggerhead. Where fires have burned we have denuded slopes like this, which are a menace to the lands below because of the danger of erosion and floods.

Fire Protection on the National Forests

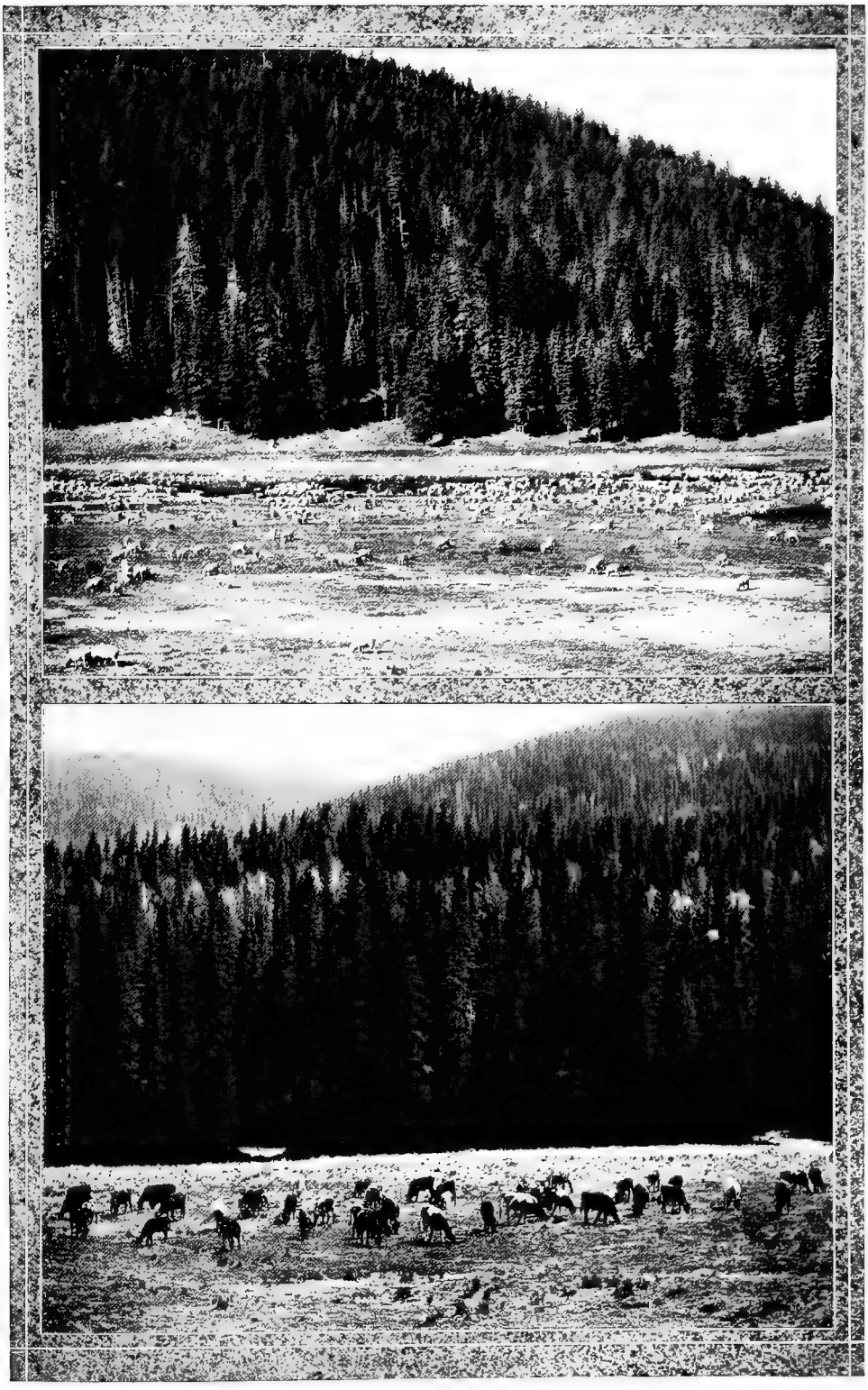
Top.—A fire-lookout station on the summit of Mount Eddy, on the Shasta National Forest, Cal. Lookout stations of this sort make possible the prompt detection of forest fires. They are connected by telephone with the headquarters of the Forest supervisor, who is thus enabled to organize and dispatch a fire-fighting crew before the fire gains any considerable headway.

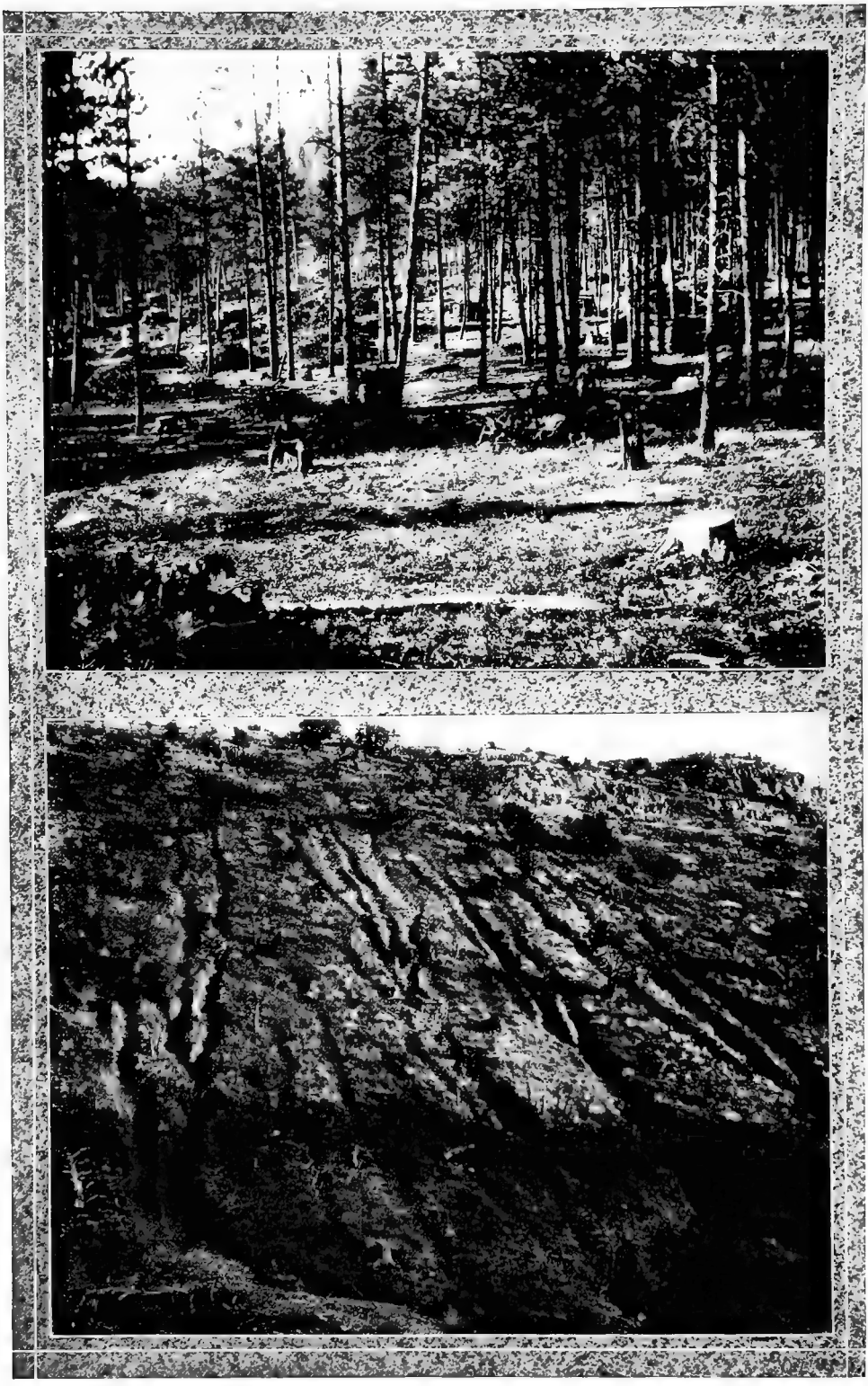
Bottom.—Extinguishing a fire on the Wasatch National Forest, Utah. In the mountains of the West axes and shovels play a much more important part than water in the suppression of forest fires.

Regulated Grazing on the National Forests

Top.—Sheep grazing on the Santa Fe National Forest, N. Mex. Approximately 7,500,000 sheep use the National Forest range each year. Damage to the vegetative cover is prevented by limiting the number of stock to the carrying capacity of the range and by proper methods of handling, such as open herding, illustrated in the picture.

Bottom.—Cattle grazing on the Santa Fe National Forest, N. Mex. Approximately 2,000,000 cattle and horses use the National Forest range each year. Full utilization of the range is secured by the proper development of water holes and salting grounds.





Good and Bad Lumbering

Top.—A National Forest timber sale. On this area in the Black Hills National Forest, S. Dak., only the mature trees have been removed, the stumps have been cut close to the ground, and the brush resulting from lumbering operations has been piled preparatory to burning as a means of reducing the fire danger. A young growth of trees will soon come in to complete the protective cover.

Bottom.—What happens when the forest goes. This slope, on the Gila National Forest in New Mexico, was formerly forested. It is now being rapidly washed away as a result of destructive lumbering and overgrazing prior to the creation of the National Forest. The eroded gullies are from 10 to 20 feet wide and from 6 to 15 feet deep. Note their size in comparison with that of the man on the left of the picture.

Act. It sometimes happened that areas were encountered which were of value both for farming and for watershed protection. When this was the case it became necessary to determine their relative value for the two purposes. The fact that throughout the West water is such a precious commodity ordinarily led to the classification of such tracts as primarily valuable for watershed protection.

A good example of the way in which this works out in actual practice is afforded by the Angeles National Forest in southern California, which is the main source of the water supply for millions of dollars' worth of citrus groves and other irrigated lands in the valleys below. These lands, which owe their high productiveness entirely to irrigation, are many times more valuable than the rather mediocre lands within the National Forest, even when the latter can be cultivated successfully. Consequently, all of the land within this National Forest, much of which is easily eroded, has been classified as primarily valuable for watershed protection wherever there was any danger that its cultivation might cause erosion or changes in stream flow that would result in damage to the irrigated lands below.

The same principle also applies in the case of lands primarily valuable for municipal supply or for hydroelectric projects. Out of the 12,000,000 acres of land in the Western States that have been eliminated from the National Forests or opened to entry in the last five years, practically none are primarily valuable for watershed protection. The water user and his needs have been given first consideration.

Grazing

Within the National Forests is a large part of the western summer stock range. Before the creation of the Forests, this range had been so badly trampled and so heavily over-grazed that its carrying capacity had been seriously decreased, and, what was worse from the standpoint of the water user, the protective influence of the surface cover of grass, shrubs, and small trees had been largely destroyed. In many localities overgrazing had been the cause of severe erosion, disastrous floods, and reduced stream flow during the dry season.

Grazing in the National Forests has been regulated in such a way as to repair such damage to the fullest possible extent and to prevent similar damage on areas not already affected. Not only has grazing been restricted in certain localities, but new methods of handling the stock have been intro-

duced. In the case of sheep, for example, the old method of grazing them in large, compact bodies and bringing them back night after night to the same bedding ground, which proved so injurious to both forage and soil, has been replaced by handling them in smaller, more open bands and by bedding them down wherever night overtakes them. Cattle are prevented from congregating too much by a proper distribution of salt and the development of watering places at the higher elevations and on the less frequented parts of the range. All stock is kept off of the range until the ground is firm enough not to be cut up by trampling. Where necessary, no grazing is allowed until the grass and other herbs have had a chance to seed.

By such measures as these the water user is protected, and at the same time the grazing industry is benefited. Under the improved methods the range is, in fact, being built up to a point where it can carry larger numbers of stock than before and still afford protection from the twin dangers of erosion and irregular stream flow.

Timber Cutting and Planting

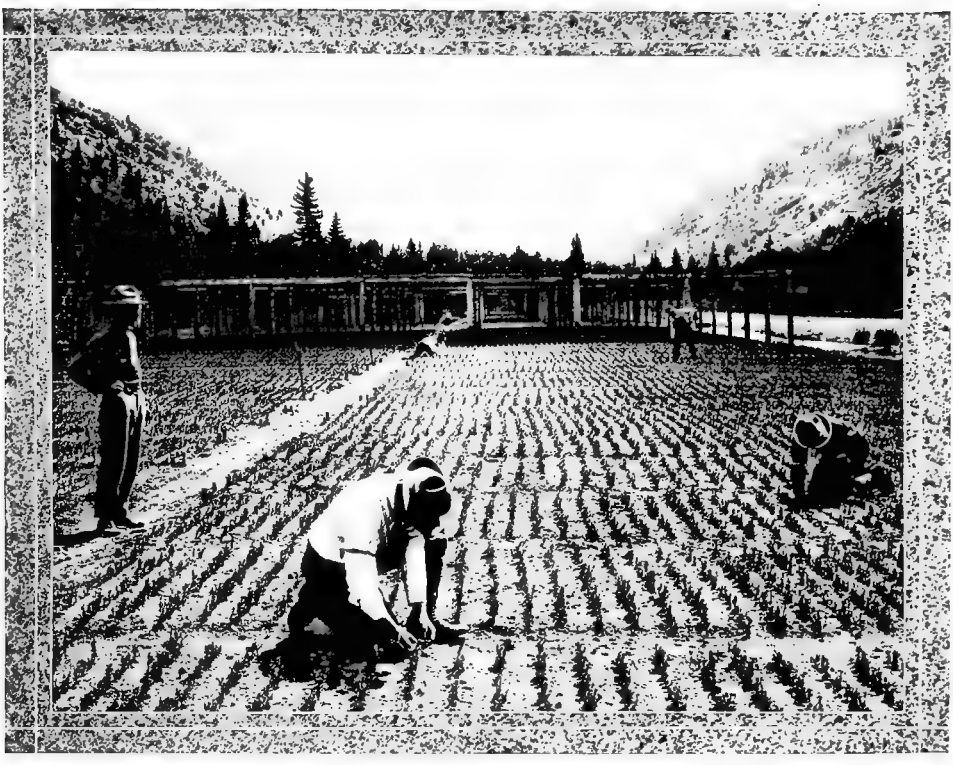
In cutting timber on the National Forests, similar precautions are taken to see that the interests of the water user are properly protected. Destructive lumbering, which too often stripped the land and abandoned it to fire, with entire disregard not only of the future timber supply, but also of the water supply, is now a thing of the past, so far as the National Forests are concerned. In its place has been substituted a system of management which assures the preservation of the forest cover and of its protective influence. At the higher elevations, where because of thin soil, steep slopes, and heavy precipitation the preservation of a fairly dense forest cover is particularly important, "protection forests" may be set aside in which little or no cutting is allowed. At lower elevations the amount of cutting that may safely be allowed naturally varies more or less with local conditions. In each case a careful study of the situation is made, and the timber is never thinned below the point of safety. Lumbering is carried on with the primary object of improving the forest and keeping it continuously productive. So far as possible, new growth is secured by natural reproduction from the old trees left standing.

Areas burned over before the creation of the National Forests need to be planted to trees. Many difficulties are encountered in this work, but as a result of experiments which the Forest Service has carried on for

Planting Trees on Denuded Lands

Top.—Transplant beds at the Cottonwood Nursery on the Wasatch National Forest in Utah. About 10,000,000 forest tree seedlings and transplants are grown by the Forest Service each year for use in the reforestation of denuded lands on the National Forests.

Bottom.—Tree planting on the Pike National Forest, Colo., on the watershed from which Colorado Springs derives its domestic water supply. About 10,000 acres are reforested each year by the Forest Service, mainly on watersheds from which towns and cities and irrigation projects derive their water supply.



One Method of Stream Control

A costly substitute for brush and forest cover. These check dams are part of a series of approximately 400 dams constructed in Haines Canyon on the Angeles National Forest in southern California at a cost of some $6,000 in order to control the floods resulting from the complete burning off of the protective brush cover.

a number of years it is now possible to go ahead in many localities with reasonable assurance of success. Planting is done principally on areas from which towns and cities or irrigation projects get their water supply.

In a word, the various activities on the National Forests are handled in such a way as to insure the fullest possible protection and utilization of the water supply as well as of the timber, forage, and other resources. One of the main objects in the creation of the National Forests was to benefit the water user and in their actual administration this end is kept constantly in view.

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