

Spring Flow Affected by Brush

removal of nearby deep-rooted plants improved water flow of springs in studies in foothills of Madera and Lake counties

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Conversion of large acreages of California brushland to grassland—to increase forage for livestock and game—has resulted, in many cases, in an increase in spring and stream flow.

Long range studies—1949–1957—chiefly in the foothills of Madera County with one small segment in Lake County, were undertaken to observe the situations under which water flow increase occurred and to make quantitative measurements of the increase. In the Madera County foothills, at elevations between 1,200' and 3,000', rainfall increases with elevation—from about 15" to 30" annually—and falls in the winter and spring. The summers are long, hot and dry. Most of the soils are granitic with high infiltration capacity.

The results of the studies indicate that in some cases the flow might be increased markedly by removing or changing plant cover. However, every spring is different. There are differences in size of watershed, plant species and density of cover on the watershed, type of soil, geological formation, whether or not the spring is shallow or deep seated, and source of water.

In Madera County, two springs served as checks to indicate trend in flow throughout the summer without manipulation of plant cover.

In the summer of 1949 two control

burns—July 17 and August 20—were made on each side of Finegold Creek for approximately one mile. The fires burned and killed about 10% of the riparian vegetation which consisted chiefly of white alder and mule fat.

On the banks and above, the shrubs and trees consisted chiefly of chaparral whitethorn, wedgeleaf ceanothus, Mariposa manzanita, redberry, poison oak, skunk brush, bush lupine, digger pine, interior live oak, blue oak, and buckeye. These shrubs and trees were about 65% top-killed on the upper slopes but less so near the stream course where the fires were set.

One seep was found in the edge of the streambed next to the second burn, but before the fire it was nearly dry.

Following the first burn it was obvious that water increased in certain places in the creek but no photographs were taken or definite measurements made before the burn. However, three days prior to the second burn, photographic stations were established in the streambed which was nearly dry except for depressions that had filled with water following the first burn. These stations were re-photographed about three weeks after the burn when water was flowing down the creek. How much of the increase in flow resulted from the killing of the vegetation in the streambed and on the slopes or

from the gradual decline in transpiration that occurs in the early autumn before the leaves normally fall can not be determined. Also, days were getting shorter. Cooler days were not a factor since this period was uniformly clear, hot and dry.

The watershed above Grapevine Spring was 59 acres and was control burned on August 20, 1949. Coverage of brush and trees before the fire was estimated as 50%. The reduction in transpiration area by burning was approximately 80%.

Before the burn the spring produced 1½ gallons per day and 24 hours after the fire it produced 360 gallons per day.

Measurements of this spring were continued during the summer of 1950. On August 24—when the flow was about equal to that on the same date after the fire in 1949—a large grapevine near the spring was cut. After the vine was cut the flow increased by about 15 gallons per day.

On August 29, six interior live oak, two blue oak, one digger pine, and two whitethorn chaparral plants near the spring were cut but no increase in spring flow followed.

In the early summer of 1951 a seep above the spring was developed for livestock water and further measurements were prevented.

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Finegold Creek. Left, dry streambed before control burn. Right, stream flowing three weeks after burn.



FLOW

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Above Tank Spring the watershed was long and narrow and covered about 25 acres. It was control burned on August 9, 1950. The kill of brush and trees was nearly 100% for a considerable distance around the spring.

Tank Spring was shallow and seepage water came from the walls of the drainage way above the spring or pipe outlet for a distance of 35'. Seepage increased after the fire. Spring flow following burning was more than double that before burning, increasing from about 198 gallons per day to 486 gallons.

The watershed above Pipe Spring was 10 acres in size and control burned on August 5, 1950. Crown cover of shrubs and trees was 10%. In addition, two small grapevines, two small interior live oak, and two wedgeleaf ceanothus plants near the spring were cut by hand.

Flow of the spring increased after burning and cutting for three or four days but then the trend continued downward at a rate equal to that before treatment. The net result was that the flow was extended for 15 days.

Rock Spring had a watershed of five acres. It was control burned on July 22, 1950. The crown cover of shrubs and trees—whitethorn chapparal, wedgeleaf ceanothus, digger pine, interior live oak, manzanita, blue oak, buckeye, and red-berry—was estimated to be 65%.

The spring water comes from a crack down about 10' in solid rock. Several years ago the spring furnished water year-long for a homesteader. However, the ranch owner reported that in recent years it had gone dry each summer.

Before the control burn in July the spring had decreased rapidly in flow and—although the burn produced an excellent top-kill—no change in trend of flow was found. Apparently the deep rooted trees and shrubs had already depleted the water at this time.

Within 30' of the Mine Spring there were eight button willows, three interior live oak clumps, three coffeeberry bushes, three medium sized digger pine, and one blue oak and all were cut by hand on July 11, 1950.

The spring had been decreasing in flow rapidly before the cutting. Thereafter, the flow increased for about 15 days and then decreased and stopped flowing again about six weeks after it went dry the first time.

Spring House Spring served as a check spring with no manipulation of cover. It was located about one quarter mile from Mine Spring. It was deep-seated, the flow coming from beneath a large rock. Measurements were taken beginning June 20 and ending September 1. There was a gradual decrease in rate of flow through-

out this period. However, it was a little more rapid early in the season than later. This may have been due to drying of poison oak and buckeye on the slope above and less use of water by these plants after about mid-July.

Cap Hill Spring was the second check spring in Madera County. Its watershed had few shrubs and trees. The rate of flow was gradually downward from July 15 to September 5, 1950. The rancher reported that the spring flowed better than it did the summer before when he had to remove the cattle from the range pasture because of a lack of stock water. Rainfall in the winter and spring season of the year before was about 4" less than the year of measurements. This probably accounts for the difference in flow.

Willow Spring was found within a few miles of Clear Lake in Lake County. The spring was surrounded by a clump of willows 12' high in the center that formed a closed canopy about 35' in diameter. The spring was boxed with sidings 38" x 51". No other woody vege-



Above: before control burn of watershed, Grapevine Spring dripped 1.5 gallons of water per day. Below: after watershed was control burned, spring flowed 360 gallons per day.



tation was near the spring, but up the hill about 150 yards were a few blue oaks and 50 yards higher were blue oaks, manzanita bushes, interior live oaks and poison oak. The watershed was estimated at 7-10 acres.

Beginning at 10:00 a.m. on August 9, 1950, a record of spring flow was made every two hours until 10:00 a.m. the next day. Spring flow for the 24 hours amounted to 44.9 gallons. At 1:00 p.m. the water in the spring box fell below the outlet and was down 1 1/8" at 6:00 p.m. It then rose to 3/4" by 8:00 p.m. and water came from the outlet at 10:30 p.m.

Spring flow records were again made every two hours on August 15 when the flow amounted to 31 1/2 gallons. The day was hotter and drier than August 9. Flow from the spring stopped at 12:00 noon and began again 30 minutes past midnight. At 6:00 p.m. water in the spring box was 1 3/4" below the pipe outlet.

After the flow was measured for the second 24 hours, the willows were cut and removed, in two hours beginning at 10:00 a.m. on August 16. The spring flow began to increase almost immediately and continued to increase rapidly until the cutting was finished. Thereafter the spring flow continued rather uniformly day and night. The flow was measured every hour during daylight and every two hours during night for 48 hours after cutting. On the second day the spring produced 122.0 gallons of water which compared to 31.5 gallons before the willows were removed. Therefore, the clump of willows had been using at least 90.5 gallons of water per day. Other measurements taken on September 5, 11, and 12 showed the spring to increase by about another 20% as the area around the spring became recharged.

The willows sprouted shortly after cutting and further measurements were made periodically in 1951, 1952, and 1953. Generally the trend in spring flow was downward except for fluctuations which corresponded with temperatures and water use by the willows.

On August 20, 1953 the willows were cut a second time. The difference in flow for 24 hours before cutting and for 24 hours after cutting amounted to 63 gallons. The flow continued to increase for the remainder of the season as it did in 1950.

Buckeye Spring was located about one half mile from Willow Spring and served as the Lake County check. The surrounding area was open except for one manzanita bush and a buckeye tree nearby. Leaves of the buckeye began to dry about mid-July.

The trend in flow for this spring was downward for each of the four summer seasons.

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