special study

ECOLOGICAL CONSIDERATIONS

KINGS CANYON

NATIONAL PARK ● CALIFORNIA

ECOLOGICAL CONSIDERATIONS IN

GRANT GROVE-WILSONIA DEVELOPMENT

By

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NATIONAL PARK SERVICE

April, 1970

Problem:

Prior to the development of sound management goals for Grant Grove, and a comprehensive zoning plan for Wilsonia, it is essential that an evaluation of existing natural and physical resources in this area be made and the potential effects of expansion be analyzed. The major consideration is the amount of water available for human use without unacceptable impairment to ecological processes. During dry years, such as 1968, the Service's water system in Grant Grove is reportedly barely adequate. Except for a few scattered complaints, water has not been a limiting factor in Wilsonia.

Of equal importance is the sewage disposal problem for both the Service facility and Wilsonia. The Service system does not meet the standards prescribed for all Federal agencies and will have to be modified to conform. Although the individual sewage facilities in Wilsonia may not be in violation of the Federal provisions, they certainly fail to meet any standard relative to the relation between sewage disposal and water supply facilities. Consideration must also be given the possible ecological effects of the discharge of large amounts of effluent meeting sanitary safety standards.

Data supporting the following comments were drawn from several sources, including the staff at Sequoia Kings Canyon National Parks, applicable literature, discussion with Dr. Richard Hartesveldt of San Jose State College and personal observations. Especially helpful were Management Biologist Richard Reigelhuth and Research Biologist Bruce Kilgore of Sequoia Kings Canyon. Both gave generously of their time and were of much assistance in locating relevant information.

A preliminary report entitled "Water Resources Reconnaissance in the General Grant Grove area Kings Canyon National Parks, Calif." was prepared in cooperation with the National Park Service by R. A. LeBlanc of the United States Geological Survey. At this writing, this is an administrative report and remains subject to final revision. However, in order to synthesize all available data, pertinent information from this study is incorporated into this report.

An impressive body of literature is available on the natural resources of the Sierra Nevada, including several papers discussing giant sequoia ecology. Unfortunately, information specific to the Grant Grove-Wilsonia area is sparse. Consequently, while extrapolations from similar areas can yield useful insights, caution must be exercised in drawing conclusions from these sources.

References cited are listed in a bibliography concluding this report.

Present Water Use:

There are presently 518 campground units and the equivalent of 62 permanent residence units in the Grant Grove area. According to Rantz and Dale (1964), 100 gal. per day is required for each campground unit and 400 gal. per day for each permanent residence. By these estimates, a total yearly requirement of 76,600 gallons per day, or 53 gal. per minute, can be calculated. The Park Engineer estimates that water use approaches 100 gal. per minute during the busy summer months.

The present park reservoir system has a capacity of 250,000 gallons. The principal catchment is a 200,000 gal. reservoir located at the base of Round Meadow and charged by three springs, a filter bed and two wells. An older 50,000 gal. tank collects water from two additional wells. At 100 g.p.m., without adequate recharge, the storage facility would sustain the community for less than two full days.

Wilsonia residents depend upon individual wells for their water supply. Of the 236 improvements in the development, it is estimated that approximately 125 are occupied on a given night during the summer seasons. Using the permanent residence index of 400 g.p.d., the Wilsonia community requires 50,000 g.p.d. or about 35 g.p.m. during the heavy use period.

Feasibility of Additional Ground Water Development:

Wilsonia and Grant Grove lie mainly on the western slope of the southern part of Park Ridge. The forested slopes range from 30-40% and are sufficiently weathered so that a residual mantle covers most of the area, except where bedrock is exposed on steep slopes. Several meadows with slopes ranging from about 3-30% are associated with the watershed. The entire area is underlain by granitic bedrock, which is overlain by decomposed granitic rock and some soil.

Four perennial streams are found within the subject area: Abbott, Mill Flat, Sequoia, and Mill Creeks. Four other streams radiating from Park Ridge carry seasonal surface runoff. Even during wet years, the flows of Mill Flat and Mill Creek dwindle to almost nothing in the late fall; Sequoia and Abbotts Creeks normally maintain low level flows throughout the dry season. Associated with Sequoia and Abbotts Creeks are riparian (streamside) vegetation communities dependent upon a sustained water supply. Consequently, due to the unpredictable discharge rate, dependent biotic communities and positive aesthetics of flowing surface waters, these perennial streams should not be looked upon as an additional water source.

In his report, Le Blanc (1970 pp. 15) describes the ground water resource as follows:

"Ground water probably can be found in the study area wherever decomposed or fractured granitic rocks, or sedimentary deposits are present to form an adequate aquifer. Precipitation is ample to recharge the ground-water body, but the capacity of subsurface storage is nearly impossible to predict. In general, the meadow areas represent the most predictable and the largest, volume for volume, ground-water storage units. Neither storage nor yield can be predicted in the fractured rocks though given good fortune in site selection, the results of drilling can be excellent."

He further states (pp 16)

"Ground water does not occur solely in the unconsolidated material in the study area. The probability of finding water in fractures in the granitic rocks is high. However, depths, yields of wells, and the quantity of water available in storage cannot be predicted."

Additionally, Le Blanc (pp 21) recommends that, if modified, the existing system can probably supply the present needs of the Service. His recommendations to modify the existing system, and to permit measurement of water levels in wells and discharge from wells and springs are quoted as follows:

"Well 13S/28E-32H1 was flowing 72 g.p.m. in October 1969, but most of the water was discharging through overflow pipes to Abbott Creek. With the overflow pipes open, the pipe to the water system was discharging about 7 g.p.m. Closing the overflow pipes will stop waste and considerably increase the flow to the water system. Also, shutting the well off completely when the water is not needed will allow both water pressure and storage to maintain maximum levels. Valves installed on the overflow pipes would permit occasional measurement of the free flowing yield of the well. A valve installed in the well casing with a garden hose connector on the output side would enable measurement of head in the well. Park Service personnel expressed concern that the well might be washed out if the overflow is stopped. There was some evidence of seepage around the casing at the time of this study.

"The well casing was not cemented in at bedrock (21 feet below land surface) when the well was drilled. Grouting at the bottom of the casing and pouring a heavy concrete platform around the casing at the surface probably would alleviate the problem.

"Well 13S/38E-32K1, when tested in 1969, had sufficient yield to supply pumping demands during dry summer months. With back pressure released, the discharge of this well was about 60 g.p.m. in 1969, compared to 40 g.p.m. when the well was completed in 1964. In 1969, the water system was not receiving 60 g.p.m. from well 32K1 because, in service, the pump forces water upgradient into a reservoir. The back pressure on the pump was not measured, but certainly reduces the output from the pump. A larger pump or a revised system relieving back pressure will permit the discharge of larger quantities of water. A larger, deeper well probably will be needed to increase the yield; inadequate yield has been reported at this site during dry years (see proposed sites 2,3, and 4).

"The wells owned by the Park Service in Wilsonia were not tested. The discharge pipes of the wells would have to be modified for testing, and access is needed for water-level measurements."

Potential Ecological Impact of Further Developing Water Resource.

The analysis of any ecosystem is facilitated by the segregation of the ecosystem into its various biotic aspects. At least three separate vegetation communities must be considered in discussing possible deleterious effects of withdrawing additional water from the Park Ridge watershed. These are: meadows, riparian habitat, and the dominant conifer community. Special attention is directed toward an evaluation of potential impact to the giant sequoia tree.

Sierran meadows occur in various situations; some are flat, others exist on relatively steep slopes; some are obviously spring fed, others have no evident sustained water source; some are completely devoid of trees or brush, others are dotted with upper stratum species. Despite their different modes of origins and consequent variability, the primary factor which governs a meadow's existence is a dependable soil moisture supply (Sharsmith, 1959). Soil moisture levels act to sustain the meadow in two ways: by supporting moisture dependent sedge and grass species, and by maintaining conditions too wet for conifer seedling survival.

Succession toward more xeric (dry) conditions in meadows is a natural process, but the rate of change in the absence of human interference tends to be very slow. Due to a meadow's fragile nature, invasion by surrounding forest trees can be greatly speeded by even a slight alteration of the habitat. Coincident with invasion of forest trees is the displacement of native ground flora with more competitive exotic species, or even accelerated erosion in steeper areas. Invariably, this succession reduces the value of the site to wildlife, not to mention the loss of a pleasing visual experience.

Where sufficient recharge occurs, a small portion of the stored ground water in a meadow can be extracted without impairment of the meadow vegetation. In addition, LeBlanc (pp 16) suggests that "extractions probably will induce additional recharge from surface water, reduce natural discharge of ground water, and may permit movement of ground water into the unconsolidated material from water-filled fractures in granitic rocks of the surrounding slopes." Nevertheless, it could be very hazardous, from an ecological standpoint, to develop plans to withdraw significant amounts of water from a meadow without first considering the source of the meadow's water supply, rate of recharge, and the site and level least sensitive to water withdrawal. Wells or catchments at the base of a sloping meadow would probably cause the least disturbance to the soil moisture demands of THAT meadow.

Riparian habitat is limited to narrow corridors along Sequoia and Abbotts Creeks. As previously mentioned, both are perennial streams with low and variable discharge rates during the summer and fall. It is important to recognize that the low flow from these streams is based on flow derived from springs and seeps from ground water. Any development of additional wells in upstream aquifers could diminish the base flow, expecially during dry years. Even periodic cessation of a normally sustained flow would endanger the stability of mesic and hydrophyte (water loving) species associated with Sequoia and Abbotts Creeks.

The mixed conifer forest community, within which the giant sequoia groves are an integral part, is the dominant aspect of the ecosystem under consideration. Canopy vegetation in this forest is dominated by white fir with sugar pine a characteristic associate. Incense cedar and ponderosa pine are conspicuous elements in some areas.

Giant sequoia trees are restricted today to a series of about 75 groves extending along the west slope of the central and southern Sierra Nevada. Within Sequoia National Park are some 25 groves; another 4 groves, ranging from 100 to 3,900 acres, are found in Grant Grove and Redwood Mountain of Kings Canyon National Park. Once more extensively distributed, changing climatic conditions have acted to reduce the range to the present disjunct distribution. Although present grove boundaries seem remarkably stable, a majority of sites are undergoing a gradual decrease in density of sequoias due to low levels of regeneration. This decline in density began long before the influence of western civilization on the groves (Rundell,1969).

Several thousand pages of popular and scientific literature describe in considerable detail the sequoia tree's life history, distribution, historic and present growth rates, regeneration, associated micro and macro fauna and flora, and response to Anglo-American impact. Broad areas of agreement exist between recognized authorities as to the optimum and minimum growth requirements and consequent limiting factors. Unfortunately, some disagreement among these investigators does exist in some rather critical areas. Most importantly, in this consideration, is the role of soil moisture in delimiting the grove boundaries.

Nearly every author notes that the groves are located in areas of high soil moisture. Axelrod (1959) considered soil moisture levels in the groves to be high enough to warrant terming the grove vegetation a hydrophytic community. Robinson (1952) included giant sequoia in a list of phreatophytes (deep-rooted plant at least partially dependent upon ground water) because of its relation to riparian habitats and areas of abundant seepage. Neither of these authors based their conclusions on any quantitative analysis of soil moisture conditions. However, grove studies have shown that sequoia density in nearly all groves is higher in very mesic habitats such as meadow edges and drainage bottoms.

Despite this demonstrated need for areas with high soil moisture, most investigators feel that the sequoia growth cycle is similar to that of other conifers growing in slightly dryer situations. After the snow melts, it is normal for the soil to be at or near field capacity at the onset of the growing season. Within a few weeks, the soil moisture is depleted by transpiration to the point where tree growth begins to slow. Considerable rainfall is needed to stimulate significant late season growth. The root structure of the sequoia, being widespread and shallow, is well adapted to this seasonal growth pattern. By this reasoning, growth of mature trees is probably not directly dependent upon the level of the water table, except as it feeds surface springs and seeps. Soil moisture levels adequate for seedling development are most critical. Preliminary findings by Hartesveldt (1968) show that the major cause of seedling death was dessication of the roots due to dry soil. Natural regeneration could probably occur only during unusually wet years or in sites with other sources of water.

Studies conducted by Rundell (1969) in the Giant Forest grove, Sequoia Kings Canyon National Parks, show that this particular grove experiences a periodic input of soil moisture during the dry season. Continuous soil moisture measurements did not show the expected steady depletion of moisture levels. Despite the lack of significant precipitation at Giant Forest, two surges of soil moisture content were observed over the summer. These surges correlated with times of increased runoff in the major drainage channels of the area, possibly indicating high elevation thunderstorms. This precipitation in the high Sierra appears to move through subterranean mass flow down to lower elevations, appearing in the soil profile of the sequoia groves. Rundell also concludes that seedling establishment and growth are especially sensitive to moisture stress. Detailed moisture stress measurements in white fir along gradients extending from inside Giant Forest to well outside the grove margin showed a steady rise outward during the fall. In other words, moisture stress suggesting drought conditions was found outside the grove, while stress inside the grove was relatively low.

Only Giant Forest was evaluated in this manner in this dissertation; moreover, Hartesveldt (personal communication 1970) and others are somewhat skeptical of the broad conclusions that logically come to mind from these data. Nevertheless, there is no reason to doubt the validity of this study in its limited time and space context. With this premise goes the responsibility to at least consider the broader implications. If sequoia tree regeneration in certain groves is dependent upon periodic inputs of soil moisture from subsurface sources, then intercepting this water higher in the watershed could seriously impair the grove's ability to sustain itself.

To attempt to evaluate these two quite divergent viewpoints and to focus such speculation on the problem at hand is difficult. It is very evident that different groves exhibit considerable varieties in the interacting factors supporting them. Common to both viewpoints, however, is the fact that the ecological tolerances of the seedling stage, interacting with soil moisture and temperature, delineate grove boundaries and control regenerative vigor. Mature trees will tolerate much more habitat modification without obvious damage.

Sewage Disposal

Sewage from Grant Grove has been treated by septic tank with final disposal by spray irrigation for several years. Absorption appears complete but discharge to subsurface drainage courses may occur by direct runoff or by indirect seepage from saturated soils during heavy use season. Surface drainage is to Mill Flat Creek which is tributary to the Kings River. Mill Flat Creek flows 10 plus miles through a very rugged terrain. It is unlikely to have any appreciable effect on the Kings River. The septic tank and spray field were designed to discharge a maximum of 30,000 gal. per day. During heavy use, average daily discharge approaches this maximum.

Sewage disposal in Wilsonia is by individual septic tanks, some of which are no more than perforated 55 gallon drums. Following heavy rains, coincident with soil saturation, sewage overflows occasionally create foul smelling surface seepage. In 1967 an individual became ill after drinking water from Sequoia Creek. Subsequent water analysis demonstrated that the stream was carrying pollutants, but the source was not identified.

A centralized treatment and disposal system is badly needed.

Potential Ecological Effects of Disposal of Additional Sewage

Assuming that secondary treatment is developed consistent with Federal standards, the problem boils down to an evaluation of the potential effects of spraying many thousands of gallons of relatively nutrient free water on the soil surface. It has been shown that the nutrients associated with sewage discharge do stimulate growth of sequoias and other forest species (Hartesveldt 1968). While this is not natural, it is unlikely that serious consequences will arise in the absence of high level concentrations of toxic elements.

Earlier mention was made of the relationship between high soil moisture and meadow vegetation. Water loving grasses and sedges are not fastidious about the source of their water and may be expected to appear wherever adequate soil and moisture conditions prevail. Saturated soil also precludes normal regeneration of some confier species. Finally, the soil softened by wetness provides less stable support for the roots of the effected trees and renders them more susceptable to toppling by wind and snow.

Evidence of such a change has been documented for at least one site. Hartesveldt (1962) describes the formation of an artificial meadow in Yosemite's Mariposa Grove where an overflow discharge from a water system saturated an area of about 10 acres. The meadow that developed is a dense growth of hydrophytic sedges, grasses, and flowering plants.

This is not meant to suggest that a meadow will invariably develop in association with a spray field. Slope, soil, and bedrock characteristics must complement an excessive injection of water in order to foster an artificial meadow. What is important is the location of the spray field. Several sequoia trees fell during the progressive maturation of the meadow in the Mariposa Grove. The development of a limited, "synthetic" ecosystem may of itself not be unacceptable unless it adversely affects important, geographically limited values, such as sequoia trees.

Summary

Disregarding potential ecological effects within the study area, there is probably adequate water in the Grant Grove-Wilsonia watershed to meet present demands. This is based on preliminary surveys of flowing surface water, springs, seeps, and selected wells. Hasty, insensitive development of this resource could adversely affect the overall ecosystem in three ways: 1. Remove or intercept water needed to sustain meadow conditions. 2. Remove or intercept water needed to sustain riparian communities associated with Sequoia and Abbotts Creeks. 3. Remove or intercept surface or shallow, subsurface water necessary for sequoia regeneration.

For the reasons mentioned, sustained withdrawal from springs or seeps associated with meadows, or siphoning off water from Sequoia or Abbotts Creeks is discouraged.

While much information is available on sequoia trees, there is no consensus of opinion among authorities as to what constitutes minimum requirements for sequoia seedling survival. However, there is agreement on the fact that there is a significant correlation between seedling survival and soil desiccation, and that seedling establishment defines the grove parameters.

Continuous discharge of treated sewage water could engender an artificial meadow. Tree roots within the saturated area would be weakened and toppling of the tree could result.

Present methods of sewage disposal in Wilsonia are not suitable. A centralized sewage collection system and treatment plant is badly needed.

Data Needed

It was stated at the onset of this report that specific information relative to sequoia ecology in Grant Grove, and limiting subsurface hydrological characteristics in the study area, is sparse. While this compilation has, hopefully, amplified and provided insight into at least some of the many disciplines involved in this problem, there is no substitute for supporting data. Therefore, listed as follows are specific suggestions on what type of studies are needed to assist management in defining objectives for the area:

1. Most importantly, delineate hydrologic features such as aquifer capacity, permeability, configuration, general water movement, and reliability. Such information would identify sites from which ground water not critical to surface resources could be drawn.

2. Along with identifying suitable well sites, determine potential yields by test pumping or by whatever method is feasible.

3. Determine sewage disposal capacity in order to avoid non-flushable saturation of unconsolidated mantle.

4. In order to evaluate the effects of ground water removal higher in watershed, periodically record flow rates of Abbotts and Sequoia Creeks.

5. Monitor soil moisture content from different levels along gradients extending through Grant Grove. This should be done throughout the snow free months during both wet and dry years.

6. Periodically submit for bacterial and chemical analysis samples of water from selected wells in Wilsonia.

These suggestions clearly point out the gaps which will continue to hamper management. I feel that additional consideration should be given to contracting a private consulting firm to at least consider suggestions one, two, and three. I would be pleased to assist in determining the nature and scope of the required services.

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