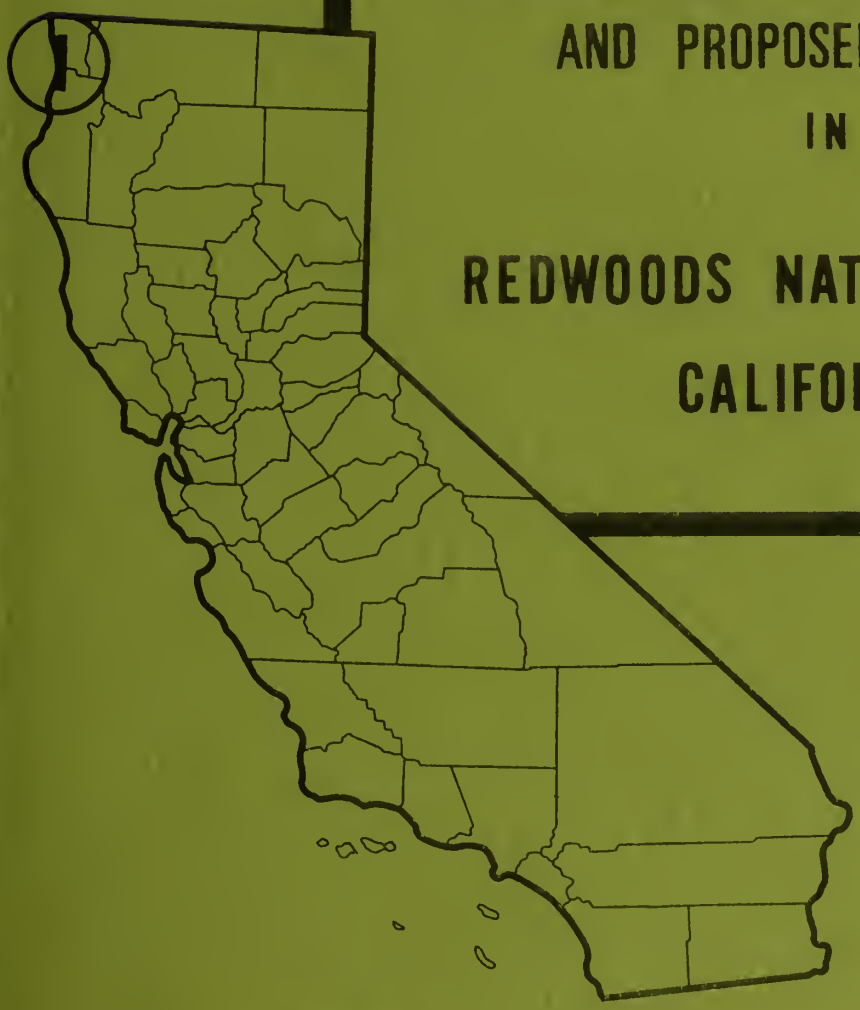
SUMMARY OF A GEOHYDROLOGICAL RECONNAISSANCE AND PROPOSED STUDIES IN REDWOODS NATIONAL PARK CALIFORNIA



ADMINISTRATIVE REPORT
For U.S. Government use only

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division
Menlo Park, California, 1969
PREPARED IN COOPERATION WITH THE
NATIONAL PARK SERVICE

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

WESTERN SERVICE CENTER
450 GOLDEN GATE AVENUE, BOX 36025
SAN FRANCISCO, CALIFORNIA 94102

IN REPLY REFER TO:

L54 (WSC)LWW
REDW/USGS
MW
Memorandum

January 29, 1970

To: Director
Attention: Chief, Water Resources Division

From: Chief, Water Resources Section, Office of Land Acquisition and Water Resources, WSC

Subject: USGS report for Redwood

This is to further my memorandum of December 1, 1969, wherein comments were requested from offices concerned, particularly regarding funding for erosional and water quality studies. Enclosed are two replies - from the Superintendent and Western Region. In that no other responses were received, it is recommended that we continue with the program for fiscal year 1970 at Redwood in accordance with my memorandum of October 23, 1969, and readjust our funding if possible in the following fiscal years to enlarge the studies.

Also enclosed is the finished report for fiscal year 1969.

Gerard S. Witucki

Enclosures W

cc:
Chief, Natural Science Studies, WASO w/enc
Chief, Div. Environmental Opns., WASO w/enc
Regional Director, Western w/enc
Superintendent, Redwood

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division

SUMMARY OF A GEOHYDROLOGICAL RECONNAISSANCE AND PROPOSED STUDIES IN REDWOODS NATIONAL PARK, CALIFORNIA

By

J. P. Akers, R. C. Averett
E. J. Helley, and J. R. Ritter

Prepared in cooperation with the
National Park Service

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Menlo Park, California
1969

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By J. P. Akers, R. C. Averett, E. J. Helley, and J. R. Ritter

INTRODUCTION

In October 1968 Congress authorized the establishment of Redwoods National Park, an area of about 90 square miles in northern California. Jedediah Smith, Gold Bluffs Beach, Del Norte Coast Redwoods, and Prairie Creek State Parks have been incorporated into the new national park. It is expected that the new status of the former state parks will result in greatly increased visitor use of the facilities of these parks as well as those of the national park as a whole.

The park and surrounding country include several large areas that have been stripped of vegetation by intensive logging. The logging operations have removed protective vegetative cover from steep slopes, which, with the road-building activities attendant to the logging have caused numerous small landslides. These conditions have given rise to problems of turbidity and increased sediment loads in some streams within the park.

The increased use of the park may overtax the present water-supply facilities and anticipated construction activities may aggravate the sediment problems. Increased visitor use of the park can result in waste loading of streams, causing pollution problems.

This report summarizes results of a reconnaissance survey conducted by Geological Survey personnel at the request of the National Park Service. This reconnaissance was the first step in a cooperative effort by the two agencies aimed at defining the present and potential hydrologic problems in Redwoods National Park. Results of the reconnaissance will be used in developing plans for further hydrologic studies.

The preliminary study was made during February and May 1969. Each of the major camping and visitor centers was visited to determine the source of the water supply, and to determine the relative suspended-sediment load and to identify any existing or potential sediment problems in the nearby streams. The water of several streams was sampled and analyzed for chemical constituents, dissolved oxygen, and alkalinity (tables 1, 2, and 3). Biologic sampling was done at selected sites in the streams to determine the benthic invertebrate population (table 4). The parameters measured in the streams are shown in table 1 and the locations where the measurements were made are shown in figure 1.

The logged areas within and adjacent to the park were visited to determine their erosion potential. Stream channels were examined to identify reaches where bank erosion occurs. The beaches were visited to determine the degree, if any, of beach erosion in progress. A geological reconnaissance was made to identify formations that might have potential for ground-water development.

A search was made of the literature relating to the water resources and geology of the area. The references are listed at the end of this report.

Table 1.--Streams, locations, and parameters measured in Redwoods National Park, February and May 1969

[Values given in tables 2, 3, and 4]

Streams	Number on map	Location	Parameter measured[1]
Clarks Creek at Highway 199	1	16N1E- 6	S
Smith River tributary below Jed. Smith Park	2	17N1E-31	S
Smith River below Jed. Smith Park	3	17N1E-30	T, DO, Alk, C, S
Smith River at gaging station	4	16N1E-10	S
Cedar Creek near mouth	5	16N1E- 9	S
Mill Creek at Jed. Smith Park	6	16N1E-18	T, DO, Alk, B, S
Nickle Creek at Enderts beach	7	15N1W-11	T, DO, Alk, S
Mill Creek outside Jed. Smith Park	8	15N1E- 6	S
Mill Creek tributary east of lumber mill	9	16N1E-32	S
Mill Creek tributary near nursery	10	15N1E- 6	S
Mill Creek at Del Norte campground	11	15N1E-17	T, DO, Alk, C, S
Prairie Creek tributary near Garden Club Grove	12	12N1E-15	S
Prairie Creek tributary at Fabins Grove	13	12N1E-23	T, DO, Alk, S
Main Prairie Creek at Fabins Grove	14	12N1E-23	T, DO, Alk, B, C, S
Brown Creek west Highway 101	15	12N1E-35	S
Boyes Creek at Park headquarters	16	11N1E- 2	T, DO, Alk, S
Godwood Creek at mouth	17	11N1E- 2	S
Prairie Creek above fish hatchery	18	11N1E-14	S
Prairie Creek below fish hatchery	19	11N1E-23	S
Lost Man Creek at fish hatchery	20	11N1E-23	S
Tributary to Lost Man Creek	21	11N1E-24	S
Little Lost Man Creek near mouth	22	11N1E-23	T, DO, Alk, B, C, S
Squashan Creek at Gold Bluffs	23	12N1E-33	T, DO, Alk, B, C, S
Redwood Creek at Orick	24	11N1E-33	T, DO, Alk, B, C, S

[1] T = temperature
DO = dissolved oxygen
Alk = alkalinity
B = biological sample of bottom fauna
C = complete chemical analysis
S = specific conductance

Table 2.--Chemical analyses of water

Results of laboratory chemical analyses for selected streams in Redwoods National Park
Samples collected May 12-13, 1969

Streams	Constituents mg/l														
	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Sum of determined constituents	Noncarbonate hardness as $CaCO_3$
U.S. Public Health Service drinking-water standards (1962)		0.3							250	250		45			
Squashan Creek	17	0.08	4.7	5.2	12	0.5	33	0.0	5.0	19	0.0	0.4	0.06	80	33
Little Lost Man Creek	7.5	.00	3.5	1.5	5.0	.4	16	.0	3.0	5.7	.0	.2	.00	35	14
Main Prairie Creek	14	.02	2.9	2.7	6.3	.2	1	.0	2.0	9.7	.0	.2	.00	38	18
Mill Creek	8.5	.00	4.0	1.1	4.0	.4	1	.0	3.0	4.5	.0	.3	.00	26	14
Smith River	10	.01	4.6	5.5	1.3	.3	3	.0	6.0	1.0	.0	.8	.02	31	34
Redwood Creek	6.1	.02	13	1.7	2.8	.6	39	.0	10	2.3	.0	.2	.01	56	40

Table 3.--Results of field chemical determinations, Redwoods National Park

Stream	Date 1969	Time (hours)	Temp. (°C)	Dissolved oxygen (mg/l)	Percent saturation dissolved oxygen	Alkalinity (mg/l HCO_3^-)	Specific conductance February 1969 (micromhos at 25°C)
Squashan Creek at Gold Bluffs	May 12	1030	10	11.1	98	38	98
Little Lost Man Creek near mouth	May 12	1145	11	11.0	100	20	52
Godwood Creek at mouth	May 12	1215	10	11.1	99	36	61
Boyes Creek at Park headquarters	May 12	1245	11	11.0	100	26	67
Main Prairie Creek at Fabins Grove	May 12	1400	10	11.1	98	22	79
Prairie Creek tributary at Fabins Grove	May 12	1430	10	11.1	98	8	128
Mill Creek at campground	May 12	1535	11	10.3	94	18	42
Smith River below Jed Smith Park	May 13	0945	11	11.0	100	39	87
Mill Creek below Jed Smith Park	May 13	1030	12	10.7	99	22	44
Nickle Creek at Enderts Beach	May 13	1130	10	11.3	100	16	61
Redwood Creek at Orlick	May 13	1330	14	10.1	97	42	122

Table 4.--Results of biological assessment of selected streams in Redwoods National Park

Stream	Date 1969	Number of organisms (2-square-foot samples)				
		Caddis flies Trichoptera	May flies Ephemeroptera	Stone flies Plecoptera	True flies Chironomid	Snails Physa
Squashan Creek at Gold Beach	May 13	0	71	1	0	0
Little Lost Man Creek near mouth	May 12	14	26	4	4	0
Main Prairie Creek at Fabins Grove	May 12	10	5	3	7	2
Mill Creek at Jed Smith Park	May 13	1	42	2	2	0
Redwood Creek at Orlick	May 13	1	9	1	0	0

SUMMARY OF RECONNAISSANCE

Water Supplies for Camp Areas

Jedediah Smith State Park

Water for Jedediah Smith State Park is obtained from a developed spring and from a shallow well or cistern in gravel along the Smith River. The spring water is used during the wet winter months when the quantity is sufficient for the camp needs; in the dry weather season of most years the spring discharge diminishes and the river water must be used.

The well, about 3 feet in diameter and 8 feet in depth, is located about 20 feet from the channel of the river. River water which infiltrates the gravel and enters the well is pumped into two, 20,000-gallon storage tanks.

The quality of water is reported to be excellent and, the combined quantity from both sources is adequate to supply the 107 campsites and the sanitary facilities of the state park.

Del Norte Coast Redwoods State Park

Water for the Del Norte Coast Redwoods State Park is obtained from a well in alluvium about 50 feet from Mill Creek. The water is pumped into a storage tank having a capacity of about 50,000 gallons.

This water supply is reported to be of good quality, and is adequate to supply the 142 campsites and sanitary facilities of the park.

Prairie Creek State Park

The Prairie Creek Headquarters area now uses water pumped from a shallow well. The water from this well is treated by aeration and soda to remove hydrogen sulfide and by alum to flocculate suspended matter. The well water is pumped into two tanks having a combined capacity of 50,000 gallons.

Gold Bluffs Beach

The 25 camping sites and 6 picnic areas at Gold Bluffs Beach are supplied with water from a tributary to Squashan Creek. This supply is adequate for present needs. However, if camping facilities are expanded this supply probably will have to be augmented from other sources.

Ground Water

It is unlikely that high-yield wells can be developed in the rocks underlying most of the park. However, in many areas limited water supplies - sufficient for a few campsites or ranger's quarters - probably could be developed from these rocks. Alluvial and terrace deposits along several of the streams have fair to good potential for the development of ground water. Moderate supplies of ground water might be developed from an extensive deposit of continental gravels in the Prairie Creek Redwoods State Park area.

Surface Water

Redwoods National Park includes part of the drainage area of several large perennial streams including the Smith and Klamath Rivers, and Mill, Prairie, Lost Man, Little Lost Man, and Redwood Creeks. Numerous small perennial streams are tributary to the larger streams or discharge directly into the Pacific Ocean. All of these streams are potential sources of water for the park.

The average annual precipitation of the park ranges from about 80 inches in the northern end to about 60 inches in the southern end. However, precipitation in the drainage basins of the Smith and Klamath Rivers probably averages more than 90 inches annually. The rainy season - from October through April - is characterized by intense rains of short to moderate duration, which sometimes, cause floods and loading of the rivers with sediment. Floodwater undercuts streambanks causing bank sloughing and landslides.

The flow regimen of the principal streams in the coastal drainage basins lying north of the south boundary of the Eel River basin is discussed in Geological Survey Water-Supply Paper 1758 (Rantz, 1964). The report includes an analysis of flow duration, flood frequency, and frequency and duration of sustained high and low flows.

Discharge data obtained at gaging stations on the Smith and Klamath Rivers and Redwood Creek are given in table 5.

Table 5.--Discharge data for the Smith and Klamath Rivers and Redwood Creek

Station	Drainage area, sq mi	Years of record	Average discharge, cfs	Acre-feet per year	Maximum discharge, cfs, and date	Minimum discharge, cfs, and date
Smith River near Crescent City	609	1931-67	3,771	2,730,000	228,000 12/22/64	160 10/24/64
Klamath River near Klamath	12,100	1910-26 and 1950-67	17,060	12,350,000	557,000 12/23/64	1,340 7/31/24 8/ 1/24
Redwood Creek at Orick	278	Sept.1911 to Sept.1913 and Oct.1953 to Sept.1967	1,072	776,100	50,500 12/22/64	10 9/22-24/11

Stream-Channel Stability

Most of the stream channels within the park boundary are stable and well protected. However, cut banks, bank sloughing, and numerous deadfalls in the Redwood, Lost Man, and Little Lost Man Creeks drainage basins indicate unstable stream channels. Unstable streambanks are undoubtedly the source of a large amount of the sediment carried by these streams.

Soil and Rock Stability

Soil and rock slides are common along Redwood and Little Lost Man Creeks in the clear-cut areas and they occur in several other areas of the park that have been logged. These slides - and potential slides - constitute construction hazards and they contribute large quantities of sediment to the streams which could endanger spawning riffles of chinook salmon and cut-throat trout (Stone and associates, 1969, p. 42).

Sediment

The reconnaissance was begun in February when stream discharge was fairly high; however, except for Lost Man, Little Lost Man, and Redwood Creeks, and the Klamath River, the streams were clear, or nearly so.

Much of the sediment load of the streams is related to logging operations both inside and outside the park. Extensive areas of clear-cut and selective logging in the Lost Man and Little Lost Man Creek drainages are underlain largely by poorly consolidated formations that are easily eroded. The myriad of skid roads created during logging, coupled with steep slopes and lack of vegetative cover, have given rise to numerous small landslides. Heavy rains in these areas cause severe erosion and consequent loading of streams with sediment.

Logging operations outside the park in the Mill Creek drainage area have created a potential to load Mill Creek with sediment and to make it esthetically unattractive.

Stream Biology

Benthic macroinvertebrate samples collected in May revealed a typical spring-season fauna (table 4). In general, the major insect groups are represented in all streams. The number of each species varied considerably, but this probably resulted from sampling procedures in which only two 1-square foot samples were collected in each stream. Animals tend to be distributed in a "patchy" manner, and limited sampling seldom captures all the forms present. More important than the numbers of organisms involved is the finding that the sensitive species, such as the may flies and caddis flies, are present. These groups indicate that past and present water-quality conditions have been very good because these species do not exist or proliferate in polluted streams.

Chemical Quality of Surface Water

Analyses of water collected from the streams within the park indicate that, chemically, the surface water is of good quality, suitable for most purposes. The specific conductance of all the streams at the sites indicated in figure 1 was less than 130 micromhos (table 1). This indicates that the concentration of dissolved solids is low. Field determinations indicated that the sampled streams maintain saturated or near-saturated dissolved oxygen (DO) levels. The lowest DO saturation - at Mill Creek - was 94 percent (table 3). This could result from organic wastes derived from the campground, but also could result from leaf fall or other natural phenomena. The cause of this lowered DO saturation and the possibility that organic wastes are entering from the Mill Creek camp should be determined.

The alkalinity, as is common in northern California coastal areas, is low. This means that the streams have a low buffering capacity so that small amounts of acidic or basic solutions will rapidly alter the pH of the water. The change in pH could cause undesirable effects on the stream biota and water quality.

Chemical data collected on selected streams are shown in table 2. Generally, the concentration of all constituents is low, and does not exceed U.S. Public Health Service standards for drinking water. Hardness is low, and is reflected by the low magnesium and calcium concentration.

The concentration of the chemical constituents is generally inversely related to stream discharge. Thus, the constituent concentrations increase in the summer as the discharge decreases, and decrease in the winter as the discharge increases. At the time of the reconnaissance, Redwood Creek at Orick had a discharge of about 700 cfs, a flow which is equalled or exceeded about 35 percent of the time. Thus, the constituent concentrations listed are probably slightly lower than would be expected during the summer. However, the ratios of the various constituents would not be expected to change with flow.

Beaches

The reconnaissance indicated that there are no beach-erosion problems at present. In fact, the evidence available indicates that the beaches along the Gold Bluffs have widened considerably in the last 120 years. Large slumps along these bluffs indicate that cliff retreat is taking place at a rapid rate, but this should pose no problem in regard to the beaches.

The fact that little or no beach existed approximately 120 years ago raises the question of why the beach subsequently formed and stabilized. Perhaps logging operations resulted in increased erosion rates and supplied the sediment that formed the beach. If this is the cause, the beach might diminish after logging has ceased in and near the park boundary. To determine the cause of the growth of Gold Bluffs beach, the source and mechanics of transport of the sand in the rivers and littoral zone must be established.

SUMMARY OF PROBLEMS AND PROPOSED STUDIES

The reconnaissance of Redwoods National Park indicates that several problems and potential problems exist in the park. These are summarized below and suggested study to supply information for alleviating the problems is outlined.

Water Supplies

The expected increase in visitors to the park will probably require that additional water supplies be developed. An orderly appraisal of the water resources would be undertaken to provide data for the development of adequate water supplies. The appraisal would include:

1. An inventory of present water supplies .
2. An appraisal of the ground-water potential of the main rock units within the park .
3. An appraisal of the important streams to determine the magnitude of their discharge, and whether or not they are perennial.
4. Detailed studies of selected sites to locate favorable areas for test drilling of wells.
5. A general appraisal of the quality of ground and surface water.

Surface Water

Records indicate that destructive floods occurred in 1955 and 1967 on the Smith and Klamath Rivers and on Redwood Creek. The lower campgrounds in Jedediah Smith campground are flooded at a river stage of about 25 feet at the USGS gage just upstream from the campground. This stage corresponds to a discharge of about 50,000 cfs which occurs almost annually. The Mill Creek campground is very near the creek level and also probably is subject to flooding at a frequent interval. The mouth of the Klamath River, within the park, is flooded almost every winter.

The recurrence interval of floods that would inundate the various campgrounds and recreation facilities would be determined, using presently available discharge records and data gathered from the gaging stations proposed below. Areas of inundation would be outlined. Stream-gaging and sediment-sampling stations would be installed on Mill Creek near the bridge on Howland Road (a station at - or very near - this site was also proposed by Stone and Associates, 1969), and on Lost Man Creek above Prairie Creek. Periodic observations of sediment and water discharge would be made at other selected sites in problem areas. In order to relate the data collected to long-term averages and to the entire Redwood Creek basin, the sediment load would be monitored continuously at the USGS stream-gaging station already in operation on Redwood Creek at Orick.

These stations, and others already in operation on the periphery of the park, would provide data for watershed management, evaluating flood hazards, management of fisheries, determining main areas of erosion, preserving the streams in the park, and designing hydraulic control structures.

Increased visitor use of the park, especially in reaches of Mill Creek downstream from Del Norte State Park area, could result in contamination of the streams. Sampling at Mill Creek and other streams in areas of potential development should be undertaken at an early stage to determine the present chemical and bacteriological quality, and should be continued to monitor any changes in water chemistry that might occur as the park is developed.

Potential Hazards

Landslide areas and deeply cut, unstable streambanks constitute potential hazards to park visitors; and unstable foundation conditions may limit construction in certain areas. These hazards, in critical areas, would be identified and their location and extent plotted on a map.

Beaches

The growth of beaches may have begun when logging operations made available large quantities of sand which were transported by the rivers to the coast. If measures are undertaken to allay the sediment loads of the rivers, the sand source for the beach growth or maintenance may be diminished and erosion of the beaches might begin.

The source of the sand that formed the beaches should be determined so that any possible effect of watershed management or erosion control on the sand source can be evaluated. This can be done by mineralogical studies of the beach sand and possible source areas, studies of littoral drift and navigational charts to determine changes in the configuration of the river deltas, and tracing of sand movement from possible source areas using sand coated with fluorescent dyes.

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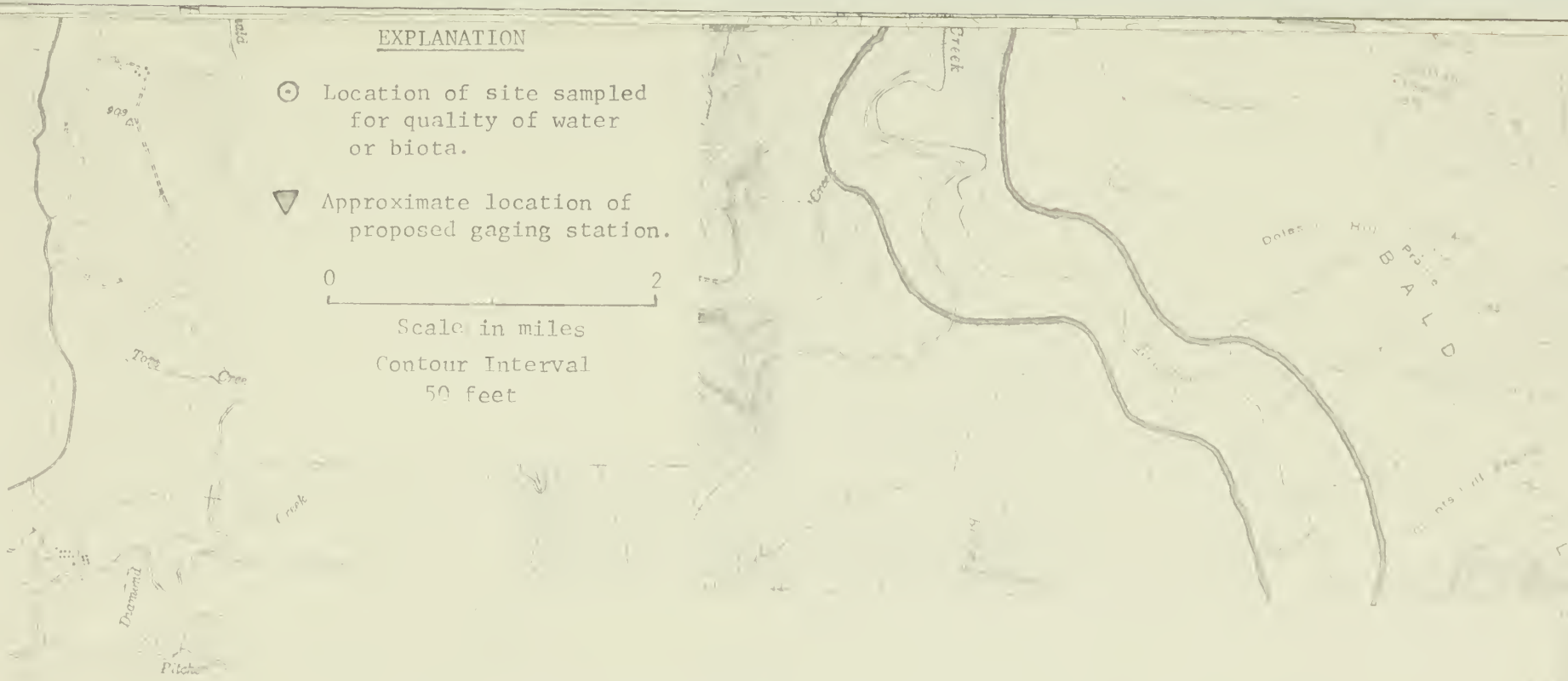

Figure 1.--Map showing location of sites sampled in Redwoods National Park, California, 1969, and approximate location of sites for proposed gaging stations. Park boundary approximate. (See table 1 for parameters determined.) Base from U.S. Geological Survey topographic maps.