SECOND PROGRESS REPORT, 1963-64

COOPERATIVE WATERSHED MANAGEMENT RESEARCH

IN THE

LOWER CONIFER ZONE OF CALIFORNIA

INTRODUCTION

        Cooperative watershed management research in California's Lower
Conifer Zone started July 1, 1961. The research is conducted by the Pacific
Southwest Forest and Range Experiment Station of the U. S. Forest Service
with the formal cooperation of the State of California, Department of Water
Resources and the Division of Forestry.

        California's Lower Conifer Zone is a 12-1/2 million-acre commercial
forest belt below the Snowpack Zone. Snow occurs in the Lower Conifer Zone,
but rainfall rather than snow contributes more than half of the streamflow in
an average year (Colman, 1955. Water is a major product. Thirty-two percent
of the State's streamflow comes from this zone. It also provides about 80
percent of the State's annual timber harvest. Wildlife, livestock grazing,
and increasing outdoor recreation make important local demands throughout the
zone. Forest fire hazards are high, and fire protection and control are basic
requirements. Mining has played a large role in creating bare soil areas,
areas of dredging debris, and sediment loads in streams.

        The job of watershed management research is to conduct studies which
will suggest better methods of management for water and predict the effects
of a wide span of land management practices upon streamflow, water yield, and
sedimentation. Our research seeks ways of managing Lower Conifer Zone
watersheds to:

        1. Increase total streamflow in all years, and especially in dry
            years.

        2. Improve timing of streamflow by reducing flood runoff and by
            reducing water losses in the late spring and summer.

        3. Maintain water quality.

        4. Minimize local floods and sedimentation.

INDIVIDUAL STUDIES

EFFECTS OF LOGGING ON STREAMFLOW, SEDIMENTATION, FISH LIFE, AND
FISH HABITAT IN THE NORTH COAST REDWOOD-DOUGLAS-FIR TYPE -
JACKSON STATE FOREST, FORT BRAGG, CALIFORNIA

Two experimental watersheds in second growth Redwood-Douglas-fir
forest type have been established on the Jackson State Forest which is
under intensive management of the State Department of Conservation,
Division of Forestry.

Objectives

Essentially no quantitative data exist on the comparative performance
of logged and unlogged watersheds in the North Coast Region. An important
concern following the December 1964 floods is the part played by forest land
management practices such as logging, road building and recreational
developments.

Answers are needed to such questions as:

1. What is the water and sediment production of North Coast
   watersheds which have been undisturbed for many years?

2. How are water yield, water quality, flood peaks and stream
   sedimentation affected when road building and logging practices
   are designed to minimize excessive runoff and erosion?

3. What changes take place in the channel following logging and
   how do these changes affect fish life and the stream habitat
   for fish?

Methods

The experimental watersheds are the North and the South Forks of
Caspar Creek, which flows into the Pacific Ocean about 5 miles south of Fort
Bragg, California (fig. 1). Each watershed is roughly 1,000 acres in size.
Both support excellent stands of dense second growth Douglas-fir and redwood
timber varying in age from 65 to 80 years. The South Fork is to be carefully
logged using the best knowledge of side slope and streambank protection
available through research and experience; the North Fork is to be left
unlogged and undisturbed as a control.

The California Department of Fish and Game is studying anadromous
fish populations in Caspar Creek and has expanded activities to include
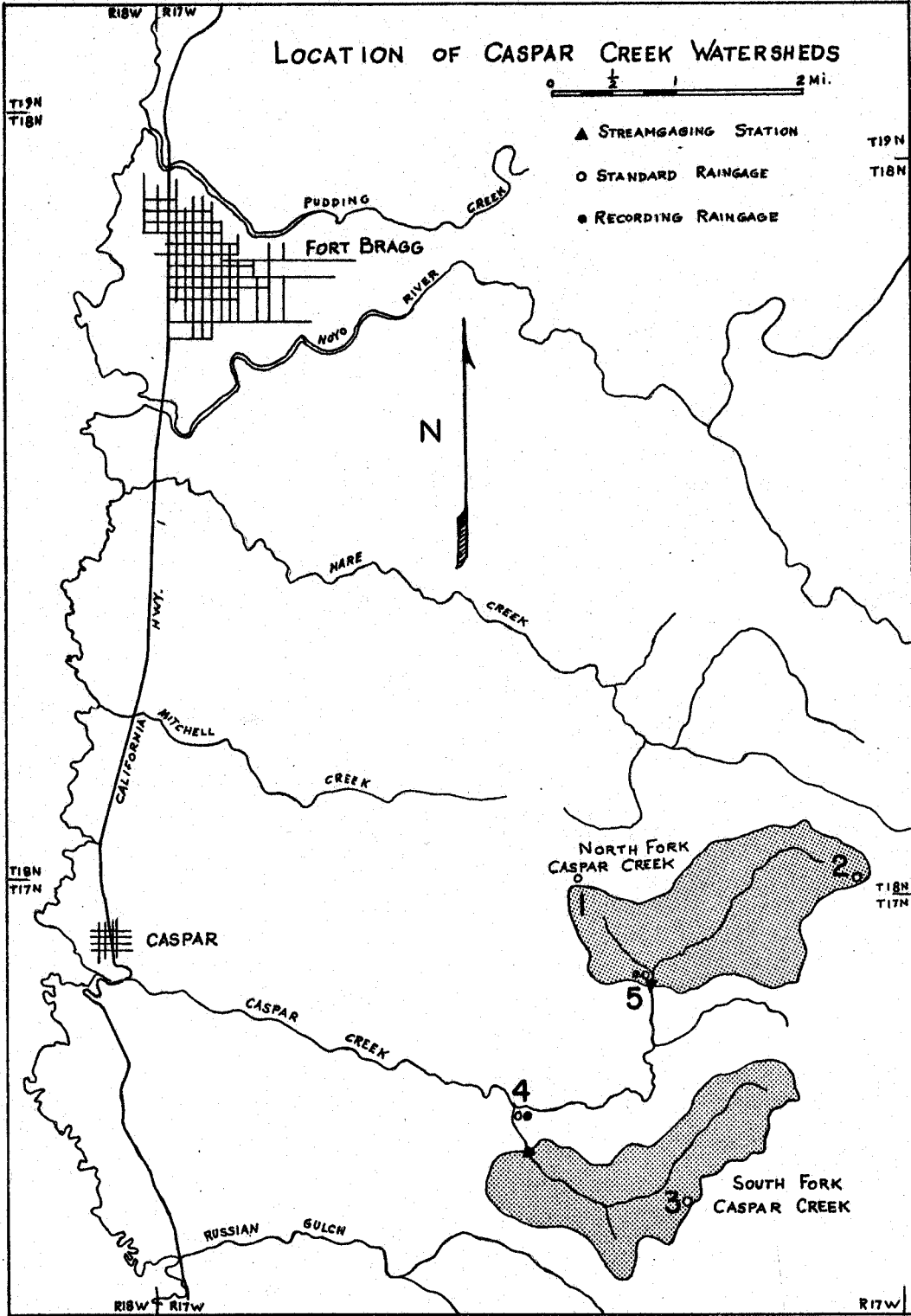habitat research in the two forks of the stream.

-2-

Figure 1.--Map of Caspar Creek area.

In September 1964, a cooperative aid project was started with University of California at Davis for the purpose of sampling stream fauna and determining the influence of logging and roads.. The study seeks to assess the differences between experimental watersheds in streamflow and sedimentation, and in fish life and fish habitat after logging.

The calibration period of this study is now in its third year. Weir construction and recorder installation in both the North and South Forks were completed early in November 1962. Streamflow records have been obtained since that time.

Watershed sediment production is being measured in two ways. One is by sampling suspended sediment during high flows both by automatic fixed stage and hand samplers. The fixed units take 2 or 4 samples for each of 8 stages in each watershed. Until August 1964, each. sample was taken 0.5 feet below the water surface. At that time we modified the arrangement so that half of the sample bottles at each fixed stage will sample 0.5 feet above the bottom of the V-notch. This change was made to assess the variability of sediment loads with depth of flow and to determine the need for getting better information on the suspended sediment profile.

The remaining measurement of sediment production is by survey of sediment deposits in the basins behind the weirs. Permanent cross sections have been established in each basin, and the surveys allow computation of volume differences between an imaginary plane above the basin and the sediment surface. Two completed annual surveys show the following accumulations for the 1963 and 1964 water years:

Watershed	Area (sq. mi.)	Water Year	Total sediment (cu. yds.)	Sediment (cu. yds./sq. mi.)
North Fork	1.92	1963	122.04	63.56
		1964	132.20	68.85
South Fork	1.63	1963	141.33	86.71
		1964	72.81	44.67

The original raingage network installed in October 1961 consisted of five standard gages. In September 1962, a recording gage (Station 4) was placed near one of the fixed gages at the confluence of the North and South Forks of Caspar Creek. A second recording gage (Station 5) was added in August of 1964, close to the North Fork weir. The present raingage network is shown in figure 1, and precipitation at Station 4 for the 1963 and 1964 water years is given in tables 1 and la.

-3 -

Table 1

DAILY PRECIPITATION AT CASPAR CREEK STATION 4

October 1962 - September 1963

(All entries in inches)

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul.	Aug	Sep
1			0.11		0.41		0.05		*			
2	0.27		1.89		.12		.21		*			
3					.02		.21					
4		0.08			.16		.05	0.17				
5							2.05	.05	0.14*			
6					.23		.56	.11				
7	.15						.37	.12				
8	.20	.07			.55	0.20	.29	.59				
9	1.45	.58			.55		.73					
10	.64	.12					.35					
11	2.95	.07					.10					
12	1.55	.46	1.18		1.14		1.35					
13	.60		.29		.02		1.45					
14	.12	.12	.14		.05	.43	.99					
15			1.26			.52	.01	*				
16			.18		.35	.88	.21	*				
17			.03				.03	*				
18					.04		.60	*				
19					.02		.20	*				
20					.11		.46	*				
21							.14	*				
22							.07	*				0.05
23						.54		*				
24						.26		*				
25		.06						*				
26		2.23				.87		*				
27						1.91		*				
28						.05		*				
29			1.14			.24		*				
30		.49	.19	1.37		.19		*				
31				1.98		.19		*				
Monthly								#	#			
Totals	7.93	4.28	5.27	4.49	3.77	6.28	10.48	1.04	0.14	0.00	0.00	0.05

Total Annual Precipitation 43.73 inches

* Indicates missing record. Value at last * is the total for this period.
# Indicates total in question due to missing record.

Table
1a

DAILY PRECIPITATION AT CASPAR CREEK STATION 4

October 1963 – September 1964

(All entries in inches)

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul.	Aug	Sep
1		0.44		0.28	*	0.63		0.07				
2				.02	*	.06		.18				
3		1.60			*			.15				
4		.17	*		*	.07		.50	0.04			
5	0.39	.41	*		0.92*	.05			.12			
6		.29	*	.85		.18			.15			
7		.27	*	.04								
8	.06	1.64	*						.10			
9	.33	.11	.68*	.22								
10	1.62								.04			
11	.13					*						
12						*						
13		.68		.48		*			.04			
14	.53	1.62		.02	.30	*						
15	1.22	.31			.05	*						
16				.31				.33				
17				1.00		*						
18			.24	1.28		1.06*						
19		1.64	.71	.69								
20			.02	2.26		.05						
21	.05			.43		.25						
22	.77	.92		.39#		.52						
23		1.39		*								
24		.02	.08	*								
25				*				.02				
26			.21	*				.15				
27		.17										
28				*	.13							
29–												
30				*		.52						
31				*		.08						
Monthly				#	#							
Totals	5.10	11.51	2.11	8.27	1.40	3.47	0.00	1.40	0.49	0.00	0.00	0.00

Total Annual Precipitation 33.75 inches

* Indicates missing record. Value at last * is the total for this period.
# Indicates total in question due to missing record.

One objective of the Caspar Creek study is to determine differences in sediment production caused by logging and road building operations. It was thought that this could be done by surveying channel cross-section spaced at random intervals. However, it is evident that more preliminary study is needed to determine precisely what should be measured and how this will fit in with the needs of the stream ecology study as well as that of sediment production. Accordingly, a supplemental study plan is being prepared and initial measurements are scheduled for the summer of 1965.

Selection of sites .for these detailed channel profiles will be based on information obtained by a geologic survey conducted in August 1964. Emphasis was directed at aspects of the geology related to slope stability. It was found that the slopes, although very steep, should be relatively stable with the exception of limited zones associated with intense shearing. A report and map were furnished the State Division of Forestry outlining recommendations.

The survey indicates need for more intensive investigation of limited areas likely to contribute a disproportionate share of sediment and was the basis for revision of the above-mentioned plan for channel surveys. In developing this plan we are considering the feasibility of detailed topographic mapping of certain unstable stream reaches, supplemented by photographs and channel cross-sections.

Stream habitat study

This year we entered into a cooperative agreement with the University of California at Davis to study fish habitat in the Caspar Creek watersheds. Dr. Kenneth Watt, ecologist, is in charge of the study.

The objectives are to study the stream bottom fauna before and after road building and logging, and to attempt to explain any changes in numbers or species composition of aquatic insect life using data furnished by all cooperating agencies. Aquatic insect fauna were selected for study since these animals occupy an intermediate trophic position and hence should serve as indicators of both terrestrial conditions and of fish habitat.

There are several technical questions which must be resolved before the data being gathered can be considered reliable. First, it must be determined if the two forks of Caspar Creek are similar in faunal composition and if variation from place to place along the course of the creek is negligible. If location contributes very little to the variance between samples the next question is how large should the sampling area be, and how many samples must be gathered to satisfy accuracy requirements (std. error = $\pm$ 10% of mean). Finally it must be

determined what is the best technique for sampling invertebrate fauna. The University will attempt to answer these questions during the 1964 fiscal year as follows:

1. The North Fork is virtually inaccessible during the winter months due to poor road conditions. Since the cost of taking samples at this time is high, sampling in the winter of 1964 has been restricted to the South Fork. As soon as weather conditions allow, sampling will begin on the North Fork. Samples for comparing the two forks will be taken during the spring and summer of 1965 provided road access is possible.

2. To study the numbers, weights, and species composition of insects in the South Fork, an efficient sampling scheme must be devised. Early samples will be examined to see if there are natural strata and if so, stratified sampling will be employed to study the populations. The number, location, and size of samples taken in the future will be based on the results obtained from samples collected in the 1964 fiscal year. A study area within the South Fork will be defined and maps of the area made. By use of these maps, random selection of sample sites will be assured. Sample sites may also be determined before arrival at the creek.

3. Devices currently being used for sampling aquatic invertebrates usually introduce some bias, i.e., they do not sample the population proportionately. A combination of sampling devices may prove to be more effective.

The current plan is to separate samples removed by the Surber sampler at the sampling site. In addition, 6 to 8 samples will be taken for separation at the University. Although this may cause a bias in the estimated number of insects, since the small insects may be overlooked, the sample may have little bias in estimating the total weight. The samples are being collected at 2- to 3-week intervals.

Reports

Reports of the study in Caspar Creek have been concerned solely with data summaries. An annual summary for hydrologic year 1963 has been completed and distributed to the cooperating agencies and a similar report for 1964 is almost completed. These summaries consist of mean daily streamflow and monthly and annual total streamflow, daily precipitation from the recording gages, and results of the annual sediment production survey. Mean daily flows for North and South Forks for 1963 water year are given in tables 2 and 3.

Table 2
North Fork Caspar Creek
Mean Daily Flow in cfs   1963 Water Year

Date	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1			2.68	0.871	34.7*	1.22	5.52	1.99	0.701	0.353	0.157	0.0930*
2			23.0	0.838	16.5	1.17	4.33	1.87	0.679	0.345	0.154	0.0910*
3			31.6	0.825	10.2	1.11	3.82	1.82	0.643	0.336	0.166 '	0.0890*
4			11.3	0.795	7.06	1.02	3.40	1.77	0.624 .	0.334	0.170	0.0880*
5			6.20	0.727	5.00	0.925	11.8*	1.72	0.627	0.332	0.167	0.0860*
6			3.92	0.675	4.02	0.911	56.9*	1.59	0.610	0.321	0.164	0.0840*
7			2.76	0.637	3.47	0.902	22.3*	1.64	0.591	0.314	0:159	0.0830*
8			2.12	0.628	4.39	0.930	14.7	1.55	0.573	0.296	0.153	0.0810*
9			1.72	0.606	5.92	0.899	11.7	1.42	0.550	0.289	0.171	0.0790*
10			1.48	0.582	7.45	0.839	16.3	1.66	0.548	0.277	0.161	0.0780*
11		0.323 1/	1.30	0.548	6.30	0.774	14.9	1.85	0.5666	0.265	0.147	0.0770*
12		0.793	1.69	0.526	8.72	0.732	22.4	1.67	0.549	0.258	0.144	0.0750*
13		0.725	5.61	0.497	14.1.	0.699	32.5	1.54	0.533	0.256	0.146	0.0730*
14		0.536	6.29	0.492	10.2	0.795	44.6	1.41	0.530	0.254	0.140	0.0720*
15		0.437	24.20	0.490	6.93	0.838	26.7	1.30	0.531	0.246	0.131	0.0710*
16		0.393	18.0	0.492	5.59	3.41	16.0	1.21	0.517	0.243 '	0.125	0.0690*
17		0.378	12.5	0.498	4.86	2.24	10.0	1.15	0.502	0.241	0.121	0.0680*
18		0.352	8.74	0.496	4.10	1.60	7.20	1.10	0.480	0.234	0.117	0.0670*
19		0.327	5.92	0.476	3.60	1.31	7.33	1.10	0.449	0.230	0.120*	0.0650*
20		0.306	4.11	0.441	3.22	1.19	8.75	1.07	0.434	0.226	0.117*	0.0587
21		0.303	3.09	0.439	2.78	1.11	9.49	1.08	0.426	0.220	0.115*	0.0587
22		0.305	2.52	0.444	2.46	1.19	7.53	1.05	0.435	0.215	0.113*	0.0608
23		0.307	2.17	0.439	2.19	1.31	5.70	0.994	0.436	0.207	0.111*	0.0648
24		0.301	1.81	0.435	1.94	1.37	4.57	0.934	0.406	0.202	0.109*	0.0652
25		0.293	1.49	0.435	1.75	1.23	4.29	0.886	0.392	0.191	0.107*	0.0655
26		9.94	1.30	0.440	1.58	1.36	3.65	0.855	0.385	0.185	0.104*	0.0642
27		8.86	1.18	0.439	1.45	22.2	3.01	0.834	0.390	0.174	0.103*	0.0610
28		4.08	1.10	0.430	1.33	24.4	2.66	0.809	0.384	0.173	0.100*	0.0584
29		2.34	0.997	0.644		12.3	2.38	0.796	0.365	0.175	0.0990*	0.056
30		2.01	0.978	7.04		8.20	2.16	0.758	0.358	0.170	0.0970*	0.0570
31			0.927	41.4*		6.69		0.729		0.162	0.0950*	
Mean cfs		1.66 2/	6.21*	2.09*	6.49*	3.38	12.9*	1.30	0.507	0.249	0.132*	0.0720*
Acre Feet			382.*	128.*	361.*	208.	767.*	79.6	30.2	15.3	8.10*	4.28*

1/ Beginning of record.
2/ Based on 20 days record

* **Figures based on estimated data.**

Table 3
South Fork Caspar Creek
Mean Daily Flow in cfs   1963 Water Year

Date	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1			1.93	0.596	27.6	0.808	4.05	1.47	0.648	0.386	0.222	0.157*
2			25.2	0.575	11.1	0.770	3.06	1.39	0.622	0.378	0.225	0.155*
3		0.194 1/	25.2	0.568	6.62	0.736	2.87	1.38	0.590	0.372	0.238	0.153*
4		0.200	7.30	0.545	4.62	0.681	2.60	1.36	0.584	0.370	0.236	0.150*
5		0.203	3.72	0.499	3.42	0.633	18.2	1.32	0.580	0.374	0.233	0.149*
6		0.201	2.35	0.473	2.88	0.624	52.8	1.23	0.563	0.363	0.233	0.147*
7		0.193	1.73	0.452	2.48	0.626	17.7	1.27	0.554	0.354	0.228	0.145*
8		0.187	1.35	0.445	3.74	0.650	14.9	1.19	0.541	0.341	0.223	0.143*
9		0.348	1.12	0.435	5.30	0.648	13.4	1.10	0.525	0.331	0.229	0.141*
10		0.394	0.974	0.422	6.71	0.604	21.8	1.35	0.516	0.319	0.218	0.139*
11		0.348	0.869	0.392	5.05	0.552	13.1	1.53	0.513	0.314	0.212	0.137*
12		0.893	1.87	0.376	7.47	0.521	20.4	1.28	0.524	0.308	0.218	0.135*
13		0.703	9.47	0.365	11.4	0.502	29.2	1.17	0.530	0.319	0.213	0.133*
14		0.466	7.09	0.363	7.11	0.636	41.6	1.08	0.534	0.312	0.198	0.132*
15		0.364	29.9	0.365	4.56	0.668	19.7	1.02	0.531	0.304	0.184	0.130*
16		0.323	13.8	0.364	3.40	4.60	11.0	0.974	0.511	0.299	0.189	0.128*
17		0.300	8.23	0.369	2.86	2.40	6.68	0.928	0.499	0.296	0.189	0.126*
18		0.281	5.47	0.370	2.35	1.52	5.12	0.905	0.484	0.287	0.180	0.125*
19		0.261	3.54 .	0.356	2.11	1.17	6.54	0.908	0.474	0.286	0.186*	0.123*
20		0.249	2.55	0.337	1.96	1.02	9.00	0.892	0.457	0.283	0.184	0.121*
21		0.249	1.96	0.339	1.72	0.921	8.71	0.916	0.450	0.277	0.181*	0.120*
22		0.246	1.65	0.342	1.53	1.05	6.04	0.902	0.452	0.273	0.179*	0.118*
23		0.243	1.43	0.339	1.38	1.28	4.34	0.861	0.445	0.264	0.176*	0.116*
24		0.238	1.18	0.339	1.24	1.33	3.26	0.816	0.427	0.259	0.174*	0.115*
25		0.230	0.999	0.339	1.13	1.13	3.11	0.774	0.423	0.250	0.172*	0.114*
26		13.6	0.865	0.339	1.03	1.39	2.62	0.754	0.420	0.241	0.170*	0.112*
27		8.80	0.793	0.342	0.949	31.7	2.14	0.748	0.423	0.234	0.168*	0.109*
28		3.34	0.731	0.339	0.875	23.4	1.91	0.737	0.415	0.242	0.165*	0.109
29		1.78	0.672	0.567		10.4	1.73	0.718	0.396	0.246	0.163*	0.109
30		1.41	0.671	10.6		6.52	1.59	0.689	0.392	0.236	0.161*	0.108
31			0.645	50.9		5.16		0.664		0.227	0.159*	
Mean cfs		1.30 2/	5.33	2.37	4.74	3.38	11.6	1.04	0.501	0.301	0.197*	0.126*
Acre Feet			328.	146.	263.	208.	693.	64.1	29.8	18.5	12.1*	7.73*

1/ Beginning of record.

2/ Based on 28 days record.   * Figures based on estimated data.

Although suspended sediment samples have been collected since 1961, determinations of sediment by volume have not yet been made. Laboratory facilities are now being completed and the backlog of work will be brought up to date, Analysis of future samples will then be kept current. It is probable that additional analyses will be made on the sediment samples for use in the riparian-ecology phase of the study.

PROCESSES OF GRAVITATIONAL MASS MOVEMENT

On the basis of preliminary studies, there is good reason to believe that the processes of soil creep and landslides constitute a major source of stream sediment in the northern Coast Ranges.

Objectives

An immediate objective is to develop basic data on rates and mechanisms of various processes of gravitational mass movement which will enable realistic determinations of their respective regional contributions to stream sediment. Ultimately, this knowledge will be applied to quantitative forecasts of the effects of fire or logging operations on volume rates of mass soil movement on specific slopes. From even a casual observation it is obvious that these effects vary widely depending upon geologic, soil and environmental factors.

North Coast Transect

A 35-mile wide transect extending across the Coast Ranges eastward from Fort Bragg has been selected for regional studies of mass wasting processes. The transect includes most major geologic units characteristic of the Coast Ranges as well as a wide range of soil, climatic and vegetation types.

Last season over 40 inclinometer holes were installed for creep measurements. Atypical preliminary field installation within the transect consists of two 3-inch vertical holes drilled 30 to 50 feet through the regolith into bedrock and separated about 150 feet apart approximately along the same contour. The holes are cased with 2-1/8 inch plastic pipe which will be resurveyed several times a year with an inclinometer capable of measuring plunge in two perpendicular vertical planes to within 70 seconds of arc. This will enable us to detect and measure soil creep to within 1/8 inch over a 10-foot thick column of soil. Rates of surface creep will also be determined by means of offset from a line of sight between drill. holes.

Moraga site

An experimental 10-acre plot South of Moraga has been established for intensive creep measurements and related soil mechanics investigations.