



# STATE FOREST NOTES

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## CASPAR CREEK WATERSHED STUDY

- A CURRENT STATUS REPORT -

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North Fork Caspar Creek Weir

<sup>1/</sup>

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## UP-DATE CASPAR WATERSHED PROJECT

### INTRODUCTION

For 16 years Jackson State Forest, managed by the California Department of Forestry, has been the site of a comprehensive watershed experiment. This experiment, on Caspar Creek five miles south of Fort Bragg on the Mendocino coast, is a cooperative project between the California Department of Forestry and the U. S. Forest Service Pacific Southwest Forest and Range Experiment Station. The California Department of Fish and Game, the California Department of Water Resources, the California Division of Mines and Geology and Humboldt State University have been cooperators in the past.

The study area is composed of two similar watersheds, the North Fork (1,228 acres) and the South Fork (1,047 acres) of Caspar Creek. The topography runs from broad rounded ridge tops to steep slopes near the stream. The underlying geology of the Caspar Creek drainage is described in PSW-93 by Krammes and Burns as sedimentary rocks of Cretaceous age. Soils mapped in the area are the Hugo and Mendocino soil series. Hard sandstone and moderately weathered coarse-grained shale are found beneath the Hugo soils. The Mendocino soil is associated with highly weathered sandstone which is often streaked with lenses of red and white clay. Weakly consolidated Pleistocene marine terrace deposits are found in less than ten percent of the South Fork. These deposits form the parent material for the Caspar and Noyo soil series.

Forest cover on both watersheds consists of fairly dense stands (60,000 board feet per acre) of second growth redwood, Douglas-fir, hemlock, grand fir and some minor hardwoods in scattered areas. These stands are now 80 to 100 years old. Both drainages were clear-cut and burned in the late 1800's, the North Fork about 15 years after the South Fork. There has been little or no disturbance since with the exception of some minor pole and piling cutting during World War II.

Undergrowth consists of huckleberry, tanoak, sword fern and other species typically found in association with redwood/Douglas-fir type.

T18N  
O C C E A N  
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P A C I F I C

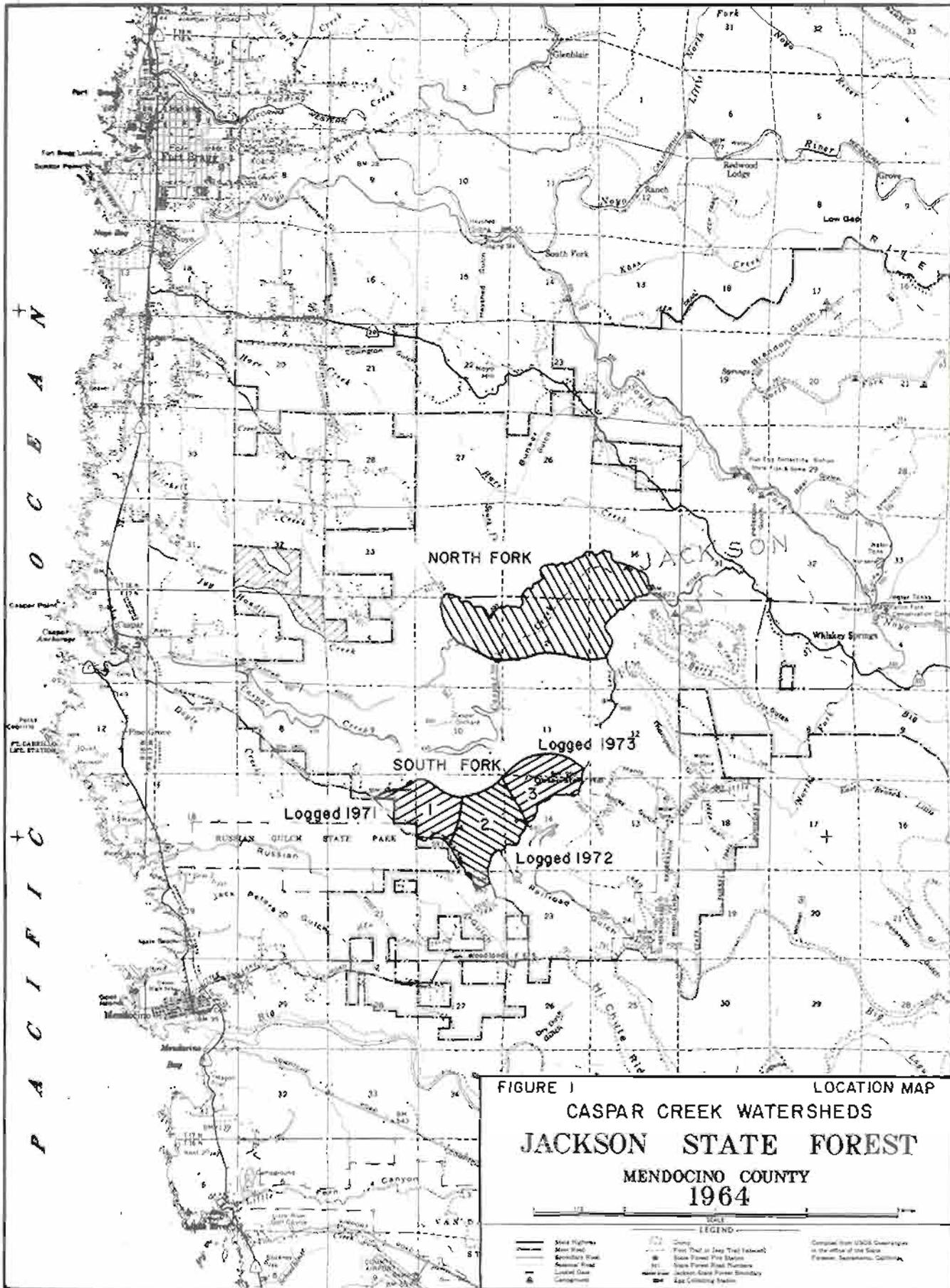


FIGURE 1 LOCATION MAP  
 CASPAR CREEK WATERSHEDS  
 JACKSON STATE FOREST  
 MENDOCINO COUNTY  
 1964

SCALE  
 0 1 2 3 4 5 6 7 8 9 10

LEGEND

—	Main Highway	—	Contour	—	Compiled from USGS Contour maps in the office of the State Forester, Eureka, California.
—	Main Road	—	Fire Trail or Jeep Trail (dashed)		
—	Secondary Road	—	State Forest Fire Station		
—	Access Road	—	State Forest Road Number		
—	Logging Case	—	Jackson State Forest Boundary		
—	Contour Interval	—	East Grading Station		

The climate can be described as that found along the northern coast of California with foggy days during the summer and mild winters with an average of 40" + rainfall each year (fig. 2).

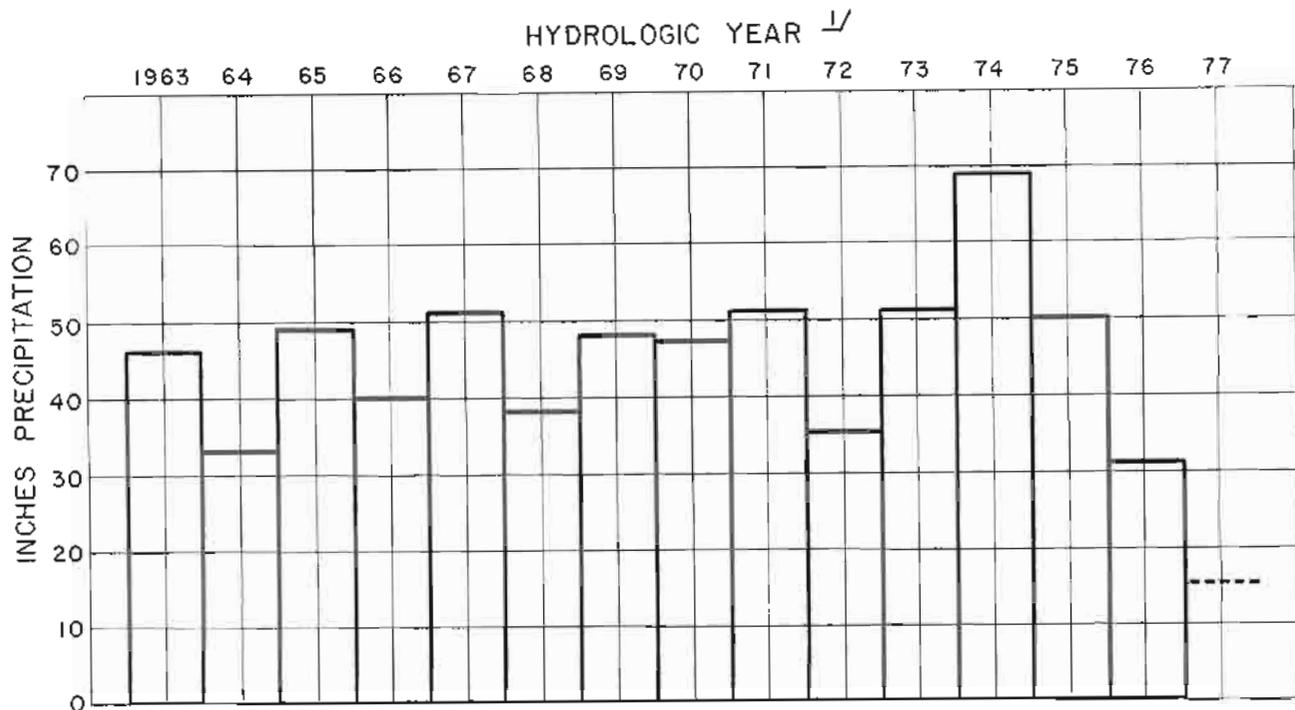


FIGURE 2 - ANNUAL PRECIPITATION CASPAR WATERSHED

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The Hydrologic Year is defined as October 1 through September 30 of the following year. The numerical designation given each hydrologic year is the same as that calendar year in which the bulk of the hydrologic year falls, i.e., October 1962 through September 1963 is hydrologic year 1963.

#### OBJECTIVES

The primary objectives of the project are to measure the sediment produced by a north coastal watershed in an undisturbed condition and to measure the degree to which water quality, flood peaks, suspended sediment, and bed load are affected by road construction and logging when practices are designed to minimize excessive runoff and erosion. This is to be done through comparing an untreated watershed, the North Fork of Caspar Creek, with a treated watershed, the South Fork of Caspar Creek.

## PROJECT HISTORY

The project was started in 1961 when a series of rain gauges were set up in and around the selected watersheds. In November 1962 installation of "V" notch weirs and attendant Stevens A-35 recording stream gauges at the lower end of both watersheds was completed. This was followed by a period of calibration during which precipitation, stream flow, suspended sediment and bed load deposits were measured. In the summer of 1967 a road system was built providing access to the South Fork watershed. From 1967 to 1971 the same measurements were taken to record the impact of this road construction. In addition, the aquatic habitat was studied to determine the changes caused by road construction. The results of this study were published in PSW-93 mentioned earlier.

In 1971 selective logging of a portion of the South Fork watershed began. The Watershed #1 Timber Sale covered 249 acres and totaled 10.3 MM board feet, or 60 percent of the volume. Watershed #2 in 1972 harvested 13.6 MM board feet and covered 316 acres. This sale resulted in removal of approximately 70 percent of the stand volume. The remaining portion of the South Fork watershed was logged in 1973. This sale, Watershed #3 removed 14.4 MM board feet or 65 percent of the volume from 435 acres. In total 38.3 MM board feet were harvested from 1,000 acres.

The average d.b.h. of timber removed was about 28". The amount of ground disturbance resulting from this selective harvest utilizing tractors and skidders is summarized in Table 1.

Table 1. Harvesting activity South Fork Watershed.

	WS #1	WS #2	WS #3	Average
Total stand/acre (MBF)	69.9	62.7	51.3	61.3
Actual harvest/acre (MBF)	41.4	43.0	33.1	38.3
				<u>Total</u>
New road construction (miles)	1.625	1.25	1.125	4
Skid trail (acres)	21.7	27.5	38.0	87.2
Landings (acres)	8.7	3.3	9.0	21.0

During and following the logging of the South Fork, drainage monitoring of both watersheds has continued. In the winter of 1973-74 sampling of the streams during storm periods was intensified. This sampling concentrated on those flows over 25 cu.ft./sec. In 1975 PS-69 automatic pumping samplers were installed on both watersheds allowing for continuous sampling. Prior to this all sampling had been done manually. During the spring of 1976 frequency controlling devices were added to these pumping samplers. This addition provided for more intensive sampling during higher flows.

The debris basins behind the weirs have each been cleaned out three times since 1962; the North Fork in 1967, 1971 and 1974, the South Fork in 1968, 1971 and 1975. Cross sections on permanent stations are measured annually and before and after each clean-out. This provides information on the amount of debris and bed load each stream produces.

## RESULTS TO DATE

### Slope Erosion

A survey of landslides in the South Fork watershed was conducted by Forestry Aides during the summer of 1976. The entire watershed was walked. The volume of landslides was estimated. Soil movements as little as 150 cubic feet were recorded. Aspect and location were noted for preparation of a base map. Color aerial photos with a scale of 4" to the mile helped confirm the accuracy of this base map. This survey showed an estimated 100 cubic yards per acre of soil displacement due to landslides.

Eighty-five percent of the slides were associated with road and skid trail cuts. A down tree or stump was present in a significant number of these slides. Whether the tree or stump helped trigger the soil displacement or was merely a victim of this displacement is difficult to determine. The volume of these individual road bank failures was not too significant; however, many of them may have affected road drainage and channeled runoff into hazardous areas thereby causing major soil movement elsewhere.

In 1976 the U. S. Forest Service, Pacific Southwest Forest and Range Experiment Station measured seven plots in the South Fork watershed. These plots were part of a larger study to assess soil movement associated with the various logging systems studied. Each plot started with a transect through a landing. Additional transects were run across the slope bisecting the skid trail system leading into the landing. Measurements were taken along these transects to determine cross sectional area of rills, gullies, ruts and cuts for skid trails or roads. All major events (defined as one cubic yard or gully cross section in excess of one square foot) within the plot were surveyed. A total measured soil loss was calculated

from this information. Fill volume (soil deposited on the site) and rut volume (which occurs more from compaction than displacement) were then subtracted from this maximum measured soil movement to arrive at a net soil loss. A total of 94 acres was sampled amounting to nine percent of the watershed. A net soil loss of 147 cubic yards per acre was recorded.

The soil movement recorded in both of these surveys did not necessarily end up in the stream. Most of it came to rest downslope from its original position.

### Stream Flow

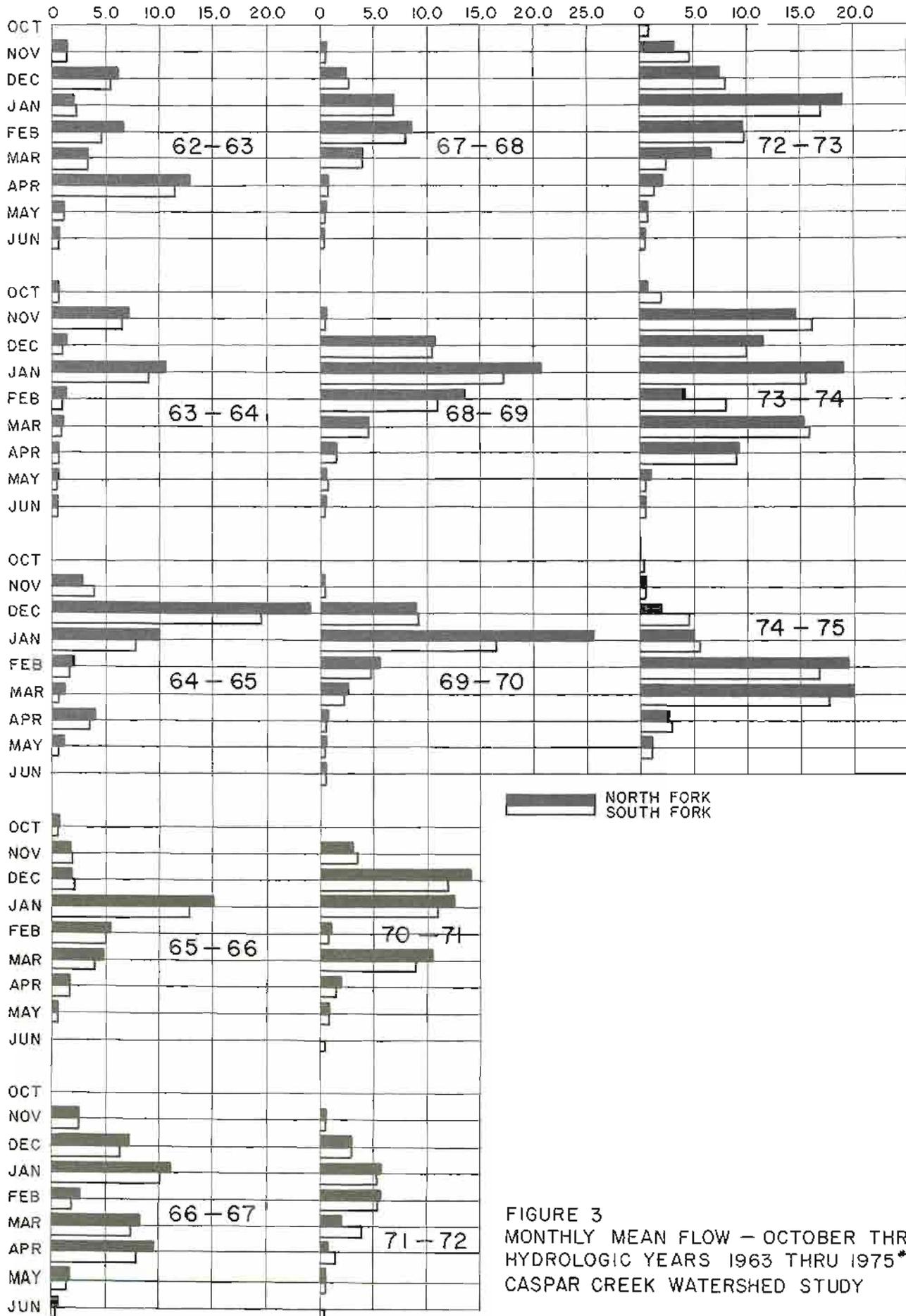
Monthly mean flow for the study period is shown in figure 3. The distribution of this flow is dependent on rainfall intensity and storm patterns for the year. In most cases the North Fork, being the larger watershed, produced a slightly greater flow in cubic feet per second (cfs) than the South Fork. Logging of the South Fork seems to have had little effect on this pattern.

Analysis of peak flow information (fig. 4) shows a fair degree of correlation between the two watersheds through the first year of logging. After that, data indicates the South Fork became much more responsive to precipitation and had more peaks over 25 cfs.

Robert Ziemer of the Pacific Southwest Forest and Range Experiment Station is doing a detailed analysis of this peak flow information. A paper on his work is forthcoming. In a comparison of flows after logging, Ziemer's preliminary analysis indicates the first three or four storms produce considerably higher peaks in the South Fork than those of the North Fork. These early peaks are, however, usually quite small in relation to peaks occurring from later storms.

As the season progresses, the differences between the peaks in the North Fork and the South Fork become insignificant. This reflects the fact that they react similarly once the soil water deficits in both watersheds have been satisfied. This also suggests that there has been little change in infiltration rate in the logged watershed due to soil compaction or disturbance.

CUBIC FT. / SEC.



NORTH FORK  
 SOUTH FORK

FIGURE 3  
 MONTHLY MEAN FLOW - OCTOBER THRU JUNE  
 HYDROLOGIC YEARS 1963 THRU 1975\*  
 CASPAR CREEK WATERSHED STUDY

\* Developed from daily mean flows including some estimated data.

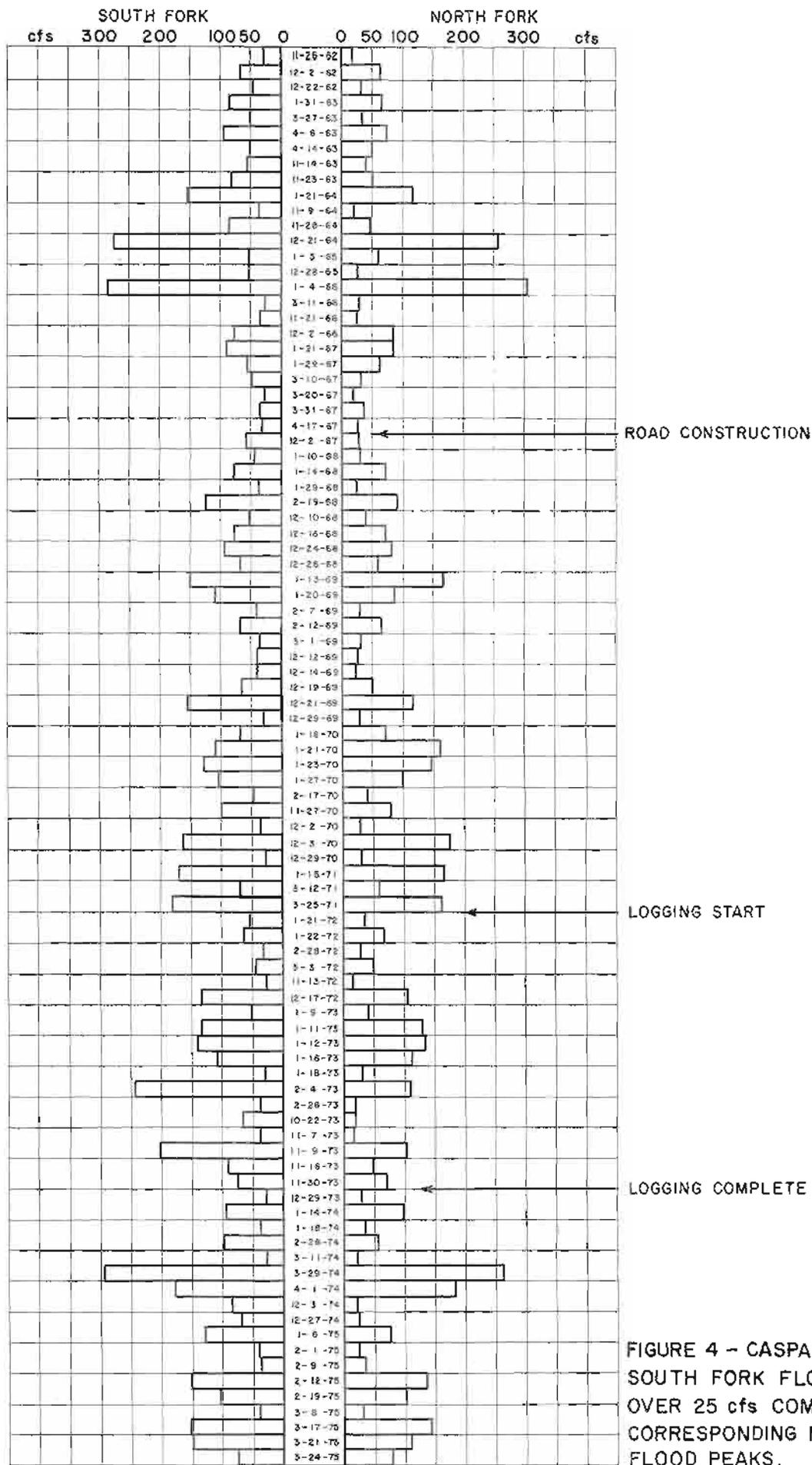


FIGURE 4 - CASPAR WATERSHED SOUTH FORK FLOOD PEAKS OVER 25 cfs COMPARED TO CORRESPONDING NORTH FORK FLOOD PEAKS.

## Debris Basin Deposits

Figure 5 is a graphical comparison of debris basin deposits behind the weirs of the two watersheds. The upper half of the figure represents debris basin deposits of the South Fork divided by the North Fork. This gives a relationship where one is the base, indicating equal magnitude; less than one indicates greater deposits in the North Fork, more than one indicates greater amounts in the South Fork. The bar graph in the lower portion of the figure indicates deposits in each basin in cubic yards per acre.

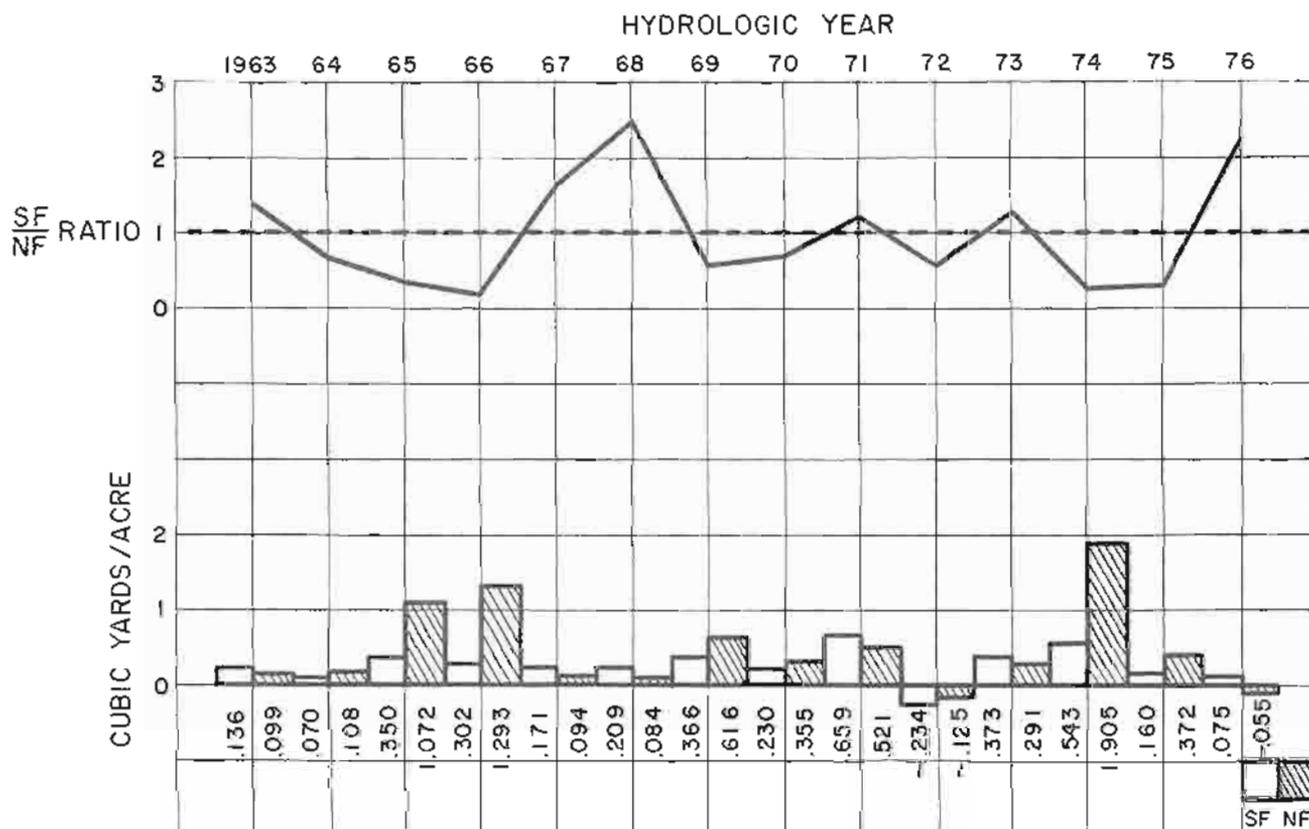


FIGURE 5 - DEBRIS BASIN DEPOSITS BEHIND NORTH FORK (NF) AND SOUTH FORK (SF) CASPAR CREEK WATERSHED WEIRS, 1963-1975.

Debris basin deposition in the South Fork appears to bear little correlation with harvesting activity. On the average the North Fork or unlogged drainage has produced more debris than the South Fork, the logged drainage. One anomaly remains unanswered: What accounts for the apparent loss of debris basin deposits in both watersheds over the 1971-72 period? The authors believe the most likely reason is settling of existing deposits. It appears the winter of 1971-72 was a fairly low year in precipitation.

Monthly mean flows never exceeded six cubic feet per second. Peak flows only exceeded 50 cfs on two occasions in either watershed and suspended sediment appears to be lower than any other year. These situations may have combined to produce little new deposits and a settling of old deposits with the net result of a recorded loss.

High deposition years on the North Fork seem to be associated with intense storms producing peaks in excess of 200 cfs coupled with mass soil movement during these peak flows. Carrying capacity is greatest at this time and most of the debris seems to be carried to the debris basin. This is borne out by personal observations after the March 1974 storm which peaked at 269 cfs. The senior author walked the length of the North Fork drainages noting one slide of approximately 1,500 cubic yards and several bank sloughages of one or two cubic yards each. There was little evidence of bed scouring or deposition in the stream channel. This indicates that debris which reached the stream was transported at least as far as the debris basin. 2,340 cubic yards of debris were deposited in the North Fork basin during the 1973-74 winter period. It is estimated that at least half of this material resulted from the March storm.

During this same period there was a slide of approximately the same magnitude in the upper portion of the South Fork. The major portion of this slide was not transported but remained in place with the stream traveling through underneath. This slide occurred in an uncut portion of the 1973 timber sale and although there is a road above it, there was no apparent drainage into the slide area from this road.

### Suspended Sediment

Figure 6 is a graphic comparison of suspended sediment concentrations in parts per million by weight. Again on the upper portion of the figure, data from the South Fork, or logged watershed, has been divided by that from the North Fork, or control watershed, giving the relationship where one means equal amounts from both watersheds. Less than one indicates more suspended sediment in the North Fork, more than one indicates the South Fork carried more suspended sediment than the North Fork. In the winter of 1967-68 an old splash dam washed out in the headwaters of the South Fork. This failure accounts for a major portion of the 895 cubic yards of suspended sediment in the South Fork for that period.

Logging of the South Fork started in 1971 and by the winter of 1972-73 (Hydrologic Year 1973) 60 percent of the watershed had been logged. An increase in suspended sediment occurred during this period and the following year but 1975 shows a decline. The high amount of suspended sediment in the North Fork for the period 1973-74 is most likely due to the slide occurring in March 1974 discussed under Debris Basin Deposits. Table 2 lists mean annual suspended sediment concentrations and annual suspended sediment discharges in the two watersheds for the hydrological years 1963-1975.

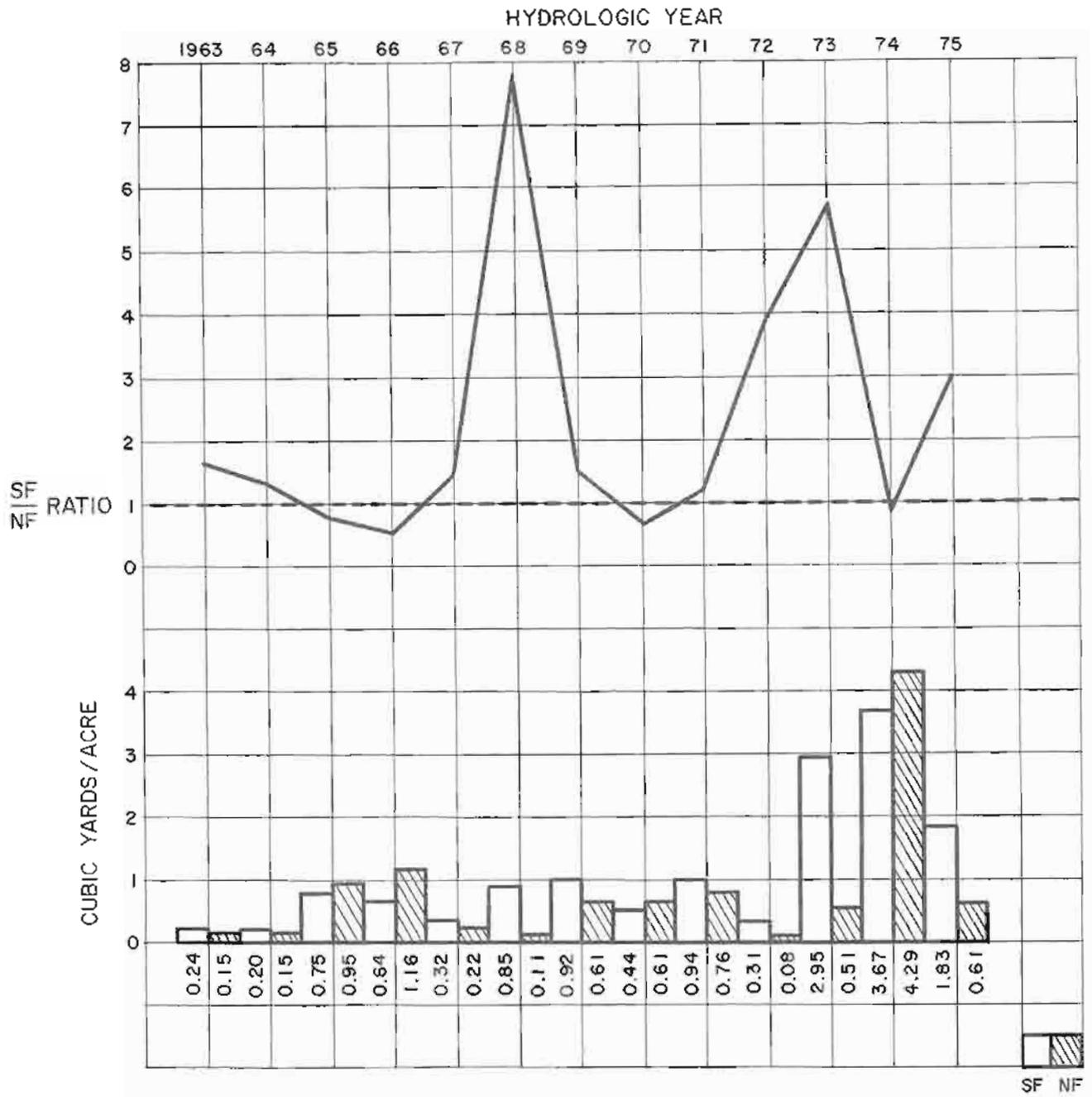


FIGURE 6 - SUSPENDED SEDIMENT COMPARISON FOR NORTH FORK (NF) AND SOUTH FORK (SF) CASPAR CREEK WATERSHED, 1963 - 1975

Table 2. Estimated Suspended Sediment of Measured Stream Flow

Hydro- Logic Year	South Fork			North Fork		
	Mean S.S.Conc. PPM	Cubic <sup>1/</sup> Yards	Cubic Yds/Ac.	Mean S.S.Conc. PPM	Cubic <sup>1/</sup> Yards	Cubic Yds/Ac.
1963	103	255	0.24	69	192	0.15
1964	132	213	0.20	98	180	0.15
1965	245	784	0.75	317	1175	0.95
1966	289	673	0.64	555	1428	1.16
1967	106	338	0.32	73	265	0.22
1968	472	895	0.85	67	130	0.11
1969	240	926	0.92	175	748	0.61
1970	160	464	0.44	205	743	0.61
1971	290	976	0.94	256	938	0.76
1972	181	326	0.31	51	98	0.08
1973	770	3090	2.95	151	625	0.51
1974	681	3840	3.67	774	5272	4.29
1975	473	1909	1.83	182	749	0.61

<sup>1/</sup>

Conversion from ppm by weight to volume figures was made on the assumption that suspended sediment weighs 74 pounds per cubic foot.

#### CONCLUSIONS

Surveys of the South Fork drainage indicate that 100 to 150 yards per acre of soil were displaced. This soil did not entirely leave the site. Only a small portion ended up in the stream. The most apparent effect of logging is on the suspended sediment. PPM increased manyfold but the volume in cubic yards per acre for the period 1971 through 1975 remains about six percent of total displacement.

The next most significant change after logging was the South Fork's response to precipitation. It became more responsive to smaller storms.

Debris basin deposits are more difficult to analyze as there is no real trend before, during or after logging. They appear to be much more dependent on storm patterns and intensities.

Table 3. Summary of soil movement by period.  
Average annual production in cubic yards per acre.

	Pre-logging 1963 - 1967		Road Calibration 1968 - 1971		Logging & Post Logging 1972 - 1975	
	NF	SF	NF	SF	NF	SF
Average Annual Suspended Sediment	.53	.43	.52	.79	1.37	2.19
Debris Basin Deposits	.46	.21	.36	.36	.63	.29

#### PROJECT FUTURE

Future plans for the Caspar Creek watershed project call for logging of the North Fork in about 1982. This allows seven or more years for the South Fork to stabilize and provide approximately 20 years of data on the North Fork in an undisturbed condition.

The silvicultural treatment planned is selective harvest of approximately 50 percent of the merchantable volume of the stand, however, the limiting factor will be the leave stand. Current objectives in stands of this type on Jackson State Forest are to leave a well spaced stand of healthy thrifty trees with approximately 200 square feet basal area per acre.

Logging plans include the use of cable yarding on the steeper slopes with tractor and rubber-tired skidders on the more gentle upper slopes. Road construction will be almost entirely on the upper one-third of the slope except where spur roads may be required to reach some scattered large residual trees. Little or no ground disturbance

should occur below the road fill. Roads are to be carefully designed and constructed to reduce drainage problems and construction failures. Tractor logging will be done at least a year in advance of the yarder portion, meaning that the operations above the road would be completed and wintered-over before operations commence below the road.

The same measurements for sediment, run-off and water quality will continue to be taken during and following logging so that a comparison may be developed between two differing logging systems. Continuation of the study within the North Fork watershed as planned will yield additional information and data to determine the effects of harvesting upon coastal watersheds.

#### LITERATURE CITED

Krammes, J. S., David M. Burns, 1973. Road Construction on Caspar Creek Watersheds, USDA, Forest Service Research Paper, PSW-93. 10 pages.

#### REPORTS TO BE PUBLISHED IN THE NEAR FUTURE

1. Analysis of peak flows on the Caspar Watershed. R. Ziemer. U. S. Forest Service, Pacific Southwest Forest & Range Experiment Station.
2. Estimating sedimentation from an erosion hazard rating. Rice and Sherbin. U. S. Forest Service, Pacific Southwest Forest & Range Experiment Station.
3. Erosion and Logging in Caspar Creek as compared to the remainder of the North Coast Region. Rice, U. S. Forest Service and Tilley, California Department of Forestry.