Geomorphic Processes and Aquatic Habitat in the Redwood Creek Basin, Northwestern California

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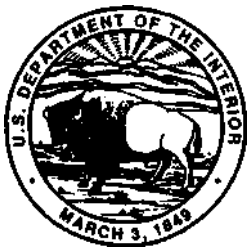

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History of Timber Harvest in the Redwood Creek Basin, Northwestern California

By DAVID W. BEST

GEOMORPHIC PROCESSES AND AQUATIC HABITAT IN THE REDWOOD CREEK BASIN, NORTHWESTERN CALIFORNIA

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HISTORY OF TIMBER HARVEST IN THE REDWOOD CREEK BASIN, NORTHWESTERN CALIFORNIA

By DAVID W. BEST[1]

ABSTRACT

Timber harvest is the dominant land use in the Redwood Creek basin. The location and timing of timber harvest throughout the basin were determined primarily by interpretation of aerial photographs. The earliest logging activities, which took place in the latter half of the 19th century, entailed the clearing of forests on the broad flood plains at the mouth of Redwood Creek. Pre-1936 commercial logging of redwoods on upper slopes in the lower basin was done with steam donkeys that cable-yarded the logs to ridgetop landings. In the late 1930's, crawler tractors replaced steam donkeys as the yarding machines. From then until the early 1960's, most of the logging was partial cuts, whereby only a portion of the stand was removed. The most intense logging period in Redwood Creek was from 1949 to 1954, and this activity was concentrated in the middle and upper parts of the basin. Logging continued to be most active in the upper two-thirds of the basin until about 1967. The timing and spatial distribution of logging indicate that the most intensive timber harvest in the upper two-thirds of the basin occurred in the 15 years prior to a major storm and flood in December 1964. During the 1960's, the harvest technique changed to tractor-yarded clearcuts, and it was during this time that logging became most heavily concentrated in the redwood-dominated lower watershed. Logging activity in the lower watershed ended abruptly with the expansion of Redwood National Park in 1978. The Z'berg-Nejedly Forest Practices Act in 1973 started a trend to more regulated and smaller tractor harvest cuts, as well as the increased use of cable-yarding systems for timber harvest on steeper slopes. Relog-ging of previously logged areas to remove residual old-growth timber became the dominant logging activity in the middle and upper watershed by 1978. By that time, 81 percent of the coniferous forests in the Redwood Creek basin had been logged.

INTRODUCTION

The timber of the Redwood Creek basin is unquestionably the basin's resource of greatest economic value (Janda and others, 1975). Over the last half century, 81 percent of the coniferous forests in the basin have been logged, requiring construction of roughly 2,000 km of roads and 9,000 km of skid trails. A combination of logging road construction and timber harvest, a sequence of intense winter storms, and inherently unstable slopes have resulted in severe erosion problems and an acceleration of erosion rates. Most erosion, such as that from hillslope gullies and streamside landslides, occurred during infrequent large storms in 1953,1955, 1964,1972, and 1975. Aerial photographs suggest the December 1964 storm caused the most drastic changes, especially in the upper portions of the watershed where logging had been most intense and most recent.

The relationship between logging, intense winter storms, and inherently unstable slopes in causing accelerated erosion is complex and difficult to assess. In an effort to clarify the above relation, this report summarizes the history of timber harvest in the Redwood Creek watershed.

ACKNOWLEDGMENTS

Dave Goodwin of the Humboldt County Assessor's Office provided 1962, 1966, and 1970 aerial photographs and copies of timber harvest maps, all of which were invaluable in determining dates and areas of timber harvest over the interval of the study. Donald Buchanan of the Humboldt County Agricultural Stabilization and Conservation Service provided 1954 aerial photographs. Laura Vander and Paul Routon aided in data compilation and drafting. Annie Kubert drafted the figures for this report. Ray Rice and Mary Ann Madej reviewed the manuscript, and comprehensive editing and review was done by Harvey Kelsey and Steven Veirs.

BASIN DESCRIPTION

Redwood Creek drains a 725-km^2 watershed located in the Coast Ranges of northern California (fig. 1). The

[1] Redwood National Park, Arcata, CA 95521.

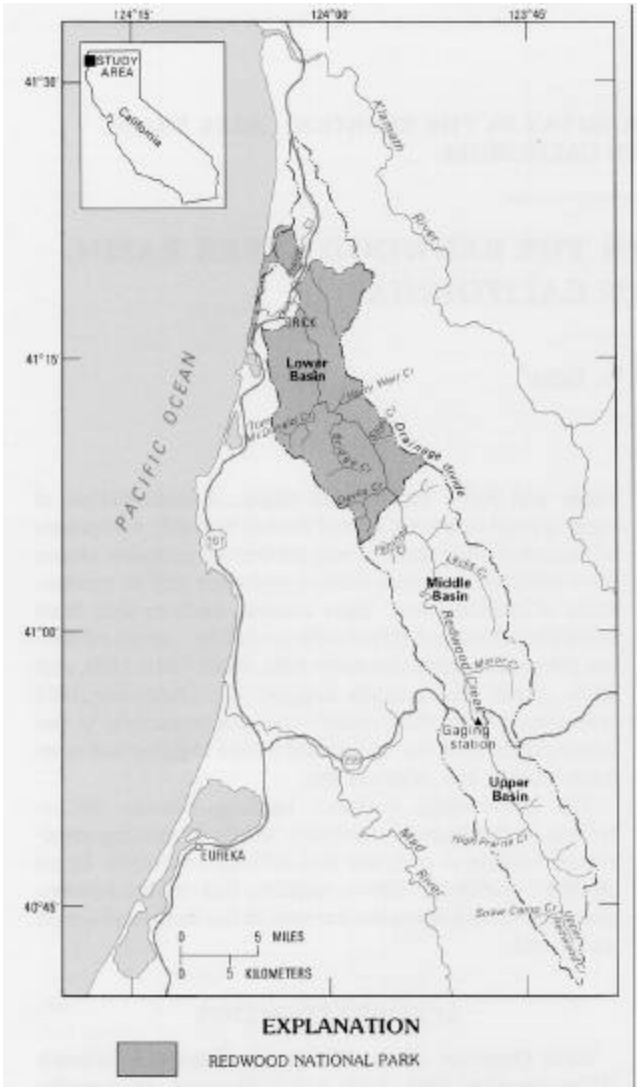

FIGURE 1.—Locations studied in the Redwood Creek basin.

creek descends from elevations of nearly 1,500 m and enters the Pacific Ocean near the town of Orick. There are 74 tributary basins drained by second order or higher streams that flow directly into Redwood Creek. Tributary channels are characteristically low-order, high-gradient streams draining small watersheds. The unusual elongate geometry (elongation ratio=0.34) of the Redwood Creek basin is a reflection of structural control due to north-northwest-trending faults in the Franciscan assemblage of Late Jurassic to Cretaceous age (Harden and others, 1982). The drainage basin is characterized by high relief, moderate to steep hillslopes, and narrow valley bottoms. Average hillslope gradient is 26 percent (Janda and others, 1975). The steepest slopes occur adjacent to stream channels and form an incised canyon called the inner gorge. Inner gorge slopes, which are especially susceptible to mass wasting, were the locations of some of the best timber prior to logging. Moderate- and low-gradient hillslopes are generally found in only midslope and upper slope positions.

Coniferous forests make up 82 percent of the natural vegetation of the watershed, whereas oak-woodlands and grasslands total 9 percent each. The vegetation of the coastal northwestern one-third of the basin is largely redwood forest (community types follow Munz, 1959) dominated by redwood *(Sequoia sempervirens)* and Douglas-fir *(Pseudotsuga menziesii)* (fig. 2). The vegetation of the inland southern two-thirds of the basin is dominated by Douglas-fir forest, changing to yellow pine forest at higher elevations near the headwaters. The distribution of coniferous forest (Redwood and Douglas-fir dominated) and prairie (fig. 2) depends largely on available soil moisture during the dry summer months. The redwood-dominated forest occurs nearer the coast where summer coastal fog is frequent. In the lower watershed, prairies occur along the watershed divide on the east side and locally continue downslope along tributary divides. In the middle and upper portions of the watershed, prairies are more common, occur on all hillslope positions (fig. 2), and are most often bounded by oak-woodland. The oak-woodland forests are dominated by Oregon white oak *(Quercus garryana).* The hardwood component of the forests in the basin was largely unharvested until 1979 when tan oak *(Lithocarpus denslflora)* chips began to be used in the manufacture of paper pulp.

DATA COLLECTION

The data compiled in this report are the result of a photointerpretive study of logging in the watershed. Aerial photographs taken in 1936,1947,1954,1962,1966, 1970, and 1978, as well as logging dates provided by the Humboldt County Timber Assessor's Office, serve as the data base for the logging unit boundaries drawn on mylar overlays of l:10,000-scale base maps. Information collected for each logging period (defined by dates of aerial photography) included area of timber harvested, yarding methods employed, and an estimate of the degree of ground disturbance. The map areas delineating these data were measured with a planimeter.

Because of differences in climate, vegetation, and logging history, the basin was divided into an upper, middle, and lower watershed. The upper watershed includes all land upstream of the U.S. Geological Survey

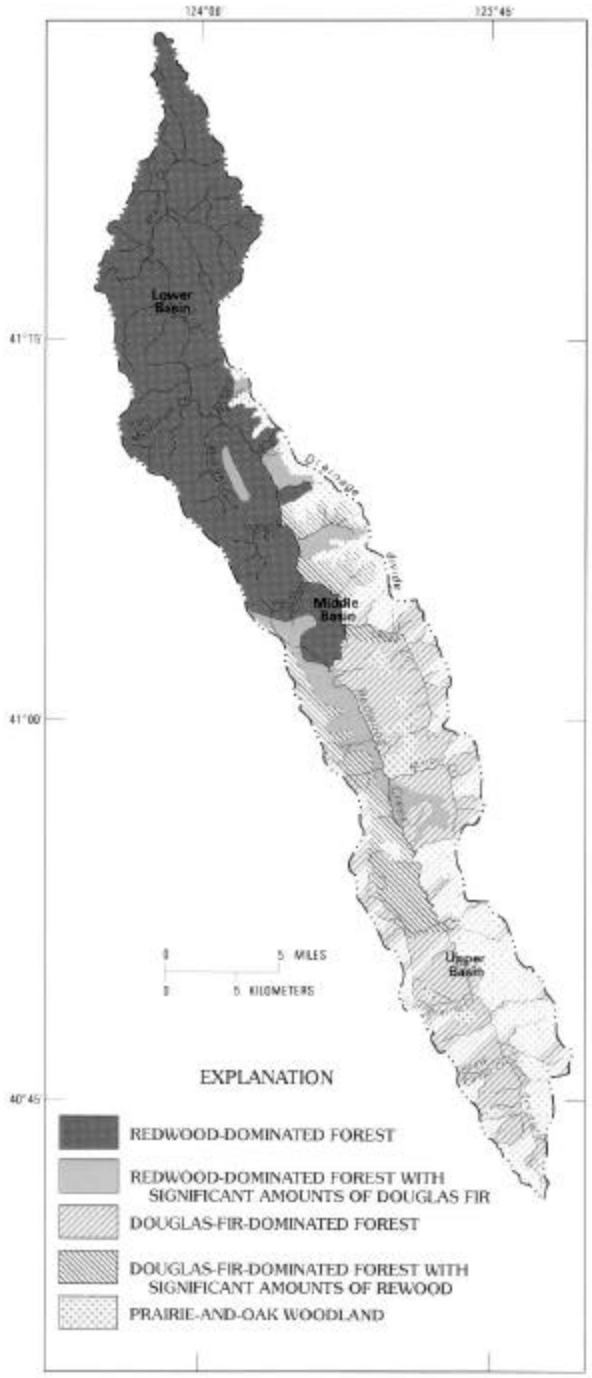

FIGURE 2.—Generalized vegetation of the Redwood Creek basin.

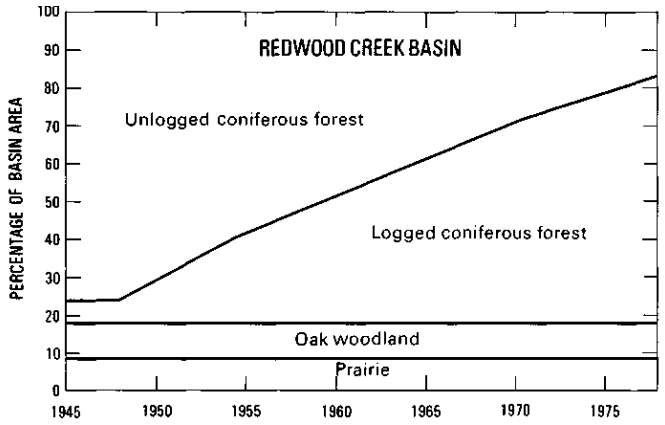

FIGURE 3.—Timber harvest in the Redwood Creek basin, showing changes in percentage of basin logged between 1945 and 1978.

gaging station near State Highway 299 (fig. 1) and has a drainage area of 173 km^2. The middle watershed includes all land downstream of the gaging station but upstream of the Redwood National Park boundary (246 km^2). The lower watershed includes all land downstream of the park boundary including the town of Orick and surrounding flood plain (197 km^2) (fig. 1). Prairie Creek, which enters Redwood Creek near the mouth, is the largest (104 km^2) tributary basin in the watershed but was excluded from the study because it drains terrain that is geologically and physiographically different from the rest of the watershed.

Periods of logging of coniferous forests and the percentage of the watershed areas involved are shown for the entire basin (Prairie Creek excluded) (fig. 3) and separately for the upper, middle, and lower watersheds (fig. 4). The data on logged area refer to only first-entry timber harvest. Many areas have been subsequently relogged to remove residual timber. This type of harvest has become increasingly important in recent years and by 1978 accounted for most of the area logged each year. However, the erosional impact of relogging is quite different from first-entry logging because fewer roads and skid trails are used and little new road construction is required.

FACTORS AFFECTING TIMBER HARVEST HISTORY

LAND OWNERSHIP

Before the establishment of Redwood National Park in 1968, less than 5 percent of the watershed was held in public ownership, mostly as several isolated parcels administered by the U.S. Forest Service and the Bureau of Land Management. Most of the land was owned by

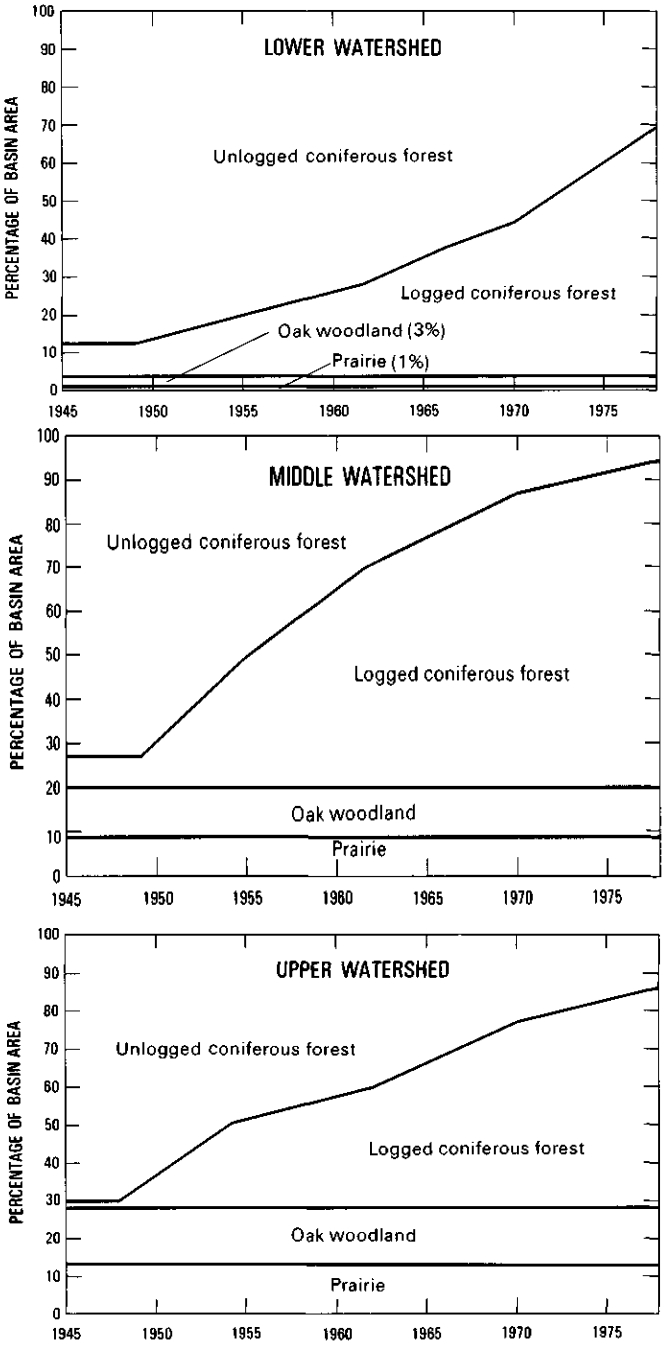

FIGURE 4.—Timber harvest history in the upper, middle, and lower watersheds in the Redwood Creek basin, showing percentage of basin logged between 1945 and 1978.

private timber companies or consisted of large family-owned ranches. As timber values increased after World War II, ranchers began logging their own lands or sold their timber rights to timber companies. As a result, virtually all the privately owned land in the basin has been available for timber harvest.

Although establishment of Redwood National Park in 1968 and its expansion in 1978 removed about 30 percent (18,600 ha) of the Redwood Creek basin from future timber harvest, only 2,550 ha of old growth redwood vegetation remained at the time of legislative taking of the lands. By 1980, nearly all of the remaining blocks of uncut timber were in public ownership, most of these in Redwood National Park, with some small, isolated U.S. Bureau of Land Management and U.S. Forest Service parcels in the middle and upper watersheds.

REGULATION OF TIMBER HARVEST

In 1945, California became the first State to regulate the private timber industry by enacting the Forest Practices Act (Arvola, 1976). Under this act, logging practice rules were formulated by District Forest Practice Committees composed of timber owners and operators. Rules became effective only after ratification by two-thirds of the timber landowners. A 1971 State court decision declared the law unconstitutional, primarily because of the issue of industry self-regulation. In 1973, after 2 years of lobbying by both the timber industry and conservationists, the Z'berg-Nejedly Forest Practices Act was enacted, establishing the current basic policies followed by the California Department of Forestry in regulating timber harvest. Therefore, by the latter half of the 1970's, timber harvest in the Redwood Creek basin was being conducted under statutes that ensured less disruptive harvest practices than were prevalent in the two previous decades.

CHANGING TIMBER HARVEST PRACTICES

Prior to 1936, the redwood forests were in most cases clearcut logged and cable-yarded by using Dolbeer steam donkeys. The yarding machinery usually hauled logs to the ridges and then to the railroads running to the mills. In the process, all the trees were cut or knocked down by the heavy cables. The crawler tractor, introduced in the late 1930's, made clearcutting unnecessary, permitting the removal of only the desired trees and leaving a portion of the stand uncut.

During the 1950's, large tracts within the basin were logged by tractor with varying amounts of timber left standing. Although true selection silviculture was recommended by some experts (Fritz, 1959), timber was left standing due to a combination of factors. These factors included the new forest practices rules for seed trees and minimum diameters and the practice of high-grading (removing only the more profitable material).

In the 1960's, timber harvest methods evolved toward more clearcutting under alternate plans approved by the Board of Forestry. Larger timber cut blocks, increased

use of tractor-constructed layouts (smooth beds of dirt onto which trees were felled to reduce stem breakage), and increased reliance on tractor-yarding resulted in increasing surface disturbance. Adjoining blocks of timber were harvested in successive years to minimize the costs associated with road construction and maintenance. Clearcutting, using crawler tractors, remained the dominant harvest method for more than a decade. In the 1970's, with new forest practice rules and increasing public concern, the use of cable-yarding systems increased, especially on steeper slopes and adjacent to the National Park boundary.

TIMBER HARVEST CHRONOLOGY

EARLY FOREST CLEARING

The wide river bottoms adjacent to Redwood Creek were cleared during the second half of the 19th and early in the 20th century. Settlers cleared the forest from the flood plains and low terraces to create more pastures and agricultural land (Janda and others, 1975). The Sitka spruce *(Picea sitchensi)* was milled locally for lumber. This clearing (visible as cleared areas that are not recently logged on 1936 aerial photographs) is approximately 2 percent of basin area, nearly all of it within the coastal flood plain.

TIMBER HARVEST BEFORE 1936

Commercial logging of redwood in the basin began in the 1930's. Cable-yarded clearcut areas are clearly visible on the 1936 aerial photographs of the lower Redwood Creek watershed. Most of the pre-1936 timber harvest was located in the headwaters of Devils Creek and Panther Creek (fig. 1). The logs were yarded by using steam donkeys and cable systems in conjunction with a logging railroad that transported the logs south out of the basin. Janda and others (1975) evaluated the impact of early steam-donkey logging in Redwood Creek by using aerial photographs and ground photographs from other nearby areas. They concluded that steam-donkey yarding techniques resulted in large clearcuts, heavy concentrations of slash, and intense localized ground disturbance surrounding landings and skid trails. However, there was less road construction and much less alteration of surface drainage patterns than is associated with large-scale tractor-yarded clearcuts typical of the 1960's.

Pre-1936 timber harvest also occurred upstream in the Douglas-fir forest, but the timber was tractor-yarded. Approximately 240 ha opposite the mouth of Minor Creek were selectively logged.

TIMBER HARVEST FROM 1936 TO 1948

Between 1936 and 1948, tractor-yarding became the dominant yarding method in the Redwood Creek watershed. Logging covered approximately 800 ha and was distributed equally in four areas: slopes just northwest of Orick, upper slopes in Tom McDonald Creek, the headwaters of Devils Creek, and the headwaters of High Prairie Creek (fig. 1). By 1948, 8 percent of the coniferous forests had been logged, accounting for 6 percent of drainage basin area (fig. 3).

TIMBER HARVEST FROM 1949 TO 1954

The period from 1949 to 1954 was the most intense interval of timber harvest in the watershed. During this period, 9,872 ha of the coniferous forests were logged, or roughly 27 percent of the original forests and 22 percent of the basin drainage area (fig. 3). Timber harvest was concentrated in the inland, Douglas-fir-dominated forests. More than half the logging during this period occurred in the middle watershed, and about one-third of the logging was located in the upper watershed. By 1954, 15 percent of the lower watershed area, 28 percent of the middle watershed area, and 22 percent of the upper watershed area had been logged (fig. 4).

Crawler tractors were used almost exclusively in timber harvest during this period. Only 15 percent of logging in the middle watershed and 9 percent of logging in the upper watershed were cable-yarded.

TIMBER HARVEST FROM 1954 TO 1962

Between 1954 and 1962, the rate of timber harvest declined substantially in both the middle and upper portions of the watershed and increased moderately in the lower watershed (fig. 3). The harvest rate for the watershed declined to 17 percent of the previous period average, despite a 40-percent increase in rate above the previous period average for the lower watershed. Crawler-tractor-yarding was again the dominant harvest method. Cable-yarding accounted for only 7 percent of the logging in the middle watershed and 14 percent of the logging in the upper watershed.

TIMBER HARVEST FROM 1962 TO 1966

Between 1962 and 1966, there was a slight increase in logging over the previous period average, but logging activity in the basin was only three-quarters of the 1949-54 rate. The 1962-66 rate of timber harvest averaged less than 60 percent the 1949-54 rate in the middle watershed but increased to 250 percent of the 1949-54

rate in the lower watershed and nearly equaled the 1949-54 rate in the upper watershed. By 1966, approximately 55 percent of the original coniferous forests had been logged from 45 percent of the drainage basin area (fig. 3).

Aerial photographs show that much of the recent logging in the upper watershed visible on the 1962 and 1966 photographs occurred in the narrow inner gorge along Redwood Creek and many of its tributaries. For access, numerous near-channel roads were constructed, and the entire area was yarded by using tractors. Many streamside landslides occurred during the 1964 storm (chaps. J and K, this volume) in these same logged areas within the inner gorge.

TIMBER HARVEST FROM 1966 TO 1970

Between 1966 and 1970, timber harvest continued at nearly the same rate in the middle watershed, declined moderately in the lower watershed, and increased considerably in the upper watershed (mostly as a result of one large 830-ha tractor-yarded clearcut) (fig. 4). Timber harvest in the upper watershed was 80 percent of the 1949-54 rate. By 1970, 65 percent of the original coniferous forests of the basin had been logged, comprising 53 percent of the drainage basin area (fig. 3). During this period, practically all logging was tractor-yarded.

TIMBER HARVEST FROM 1970 TO 1978

Timber harvest rates between 1970 and 1978 declined substantially in both the middle and upper portions of the watershed as the supply of old-growth timber was exhausted. Most of the easily accessible timber had been harvested, and logging concentrated on remaining uncut forests in the lower watershed and on the previously cut areas where old-growth timber remained. Increased demand for redwood further stimulated timber harvest in the lower watershed.

By 1978, 81 percent of the original forests had been logged over 66 percent of the drainage basin area (fig. 3). On a sub watershed basis, this logging includes 69 percent of the original forests in the lower watershed, 92 percent in the middle watershed, and 81 percent in the upper watershed, averaging 66, 73, and 59 percent of the respective drainage areas. In this period, cable-yarding became a more common harvesting technique, especially in steep areas adjacent to stream channels. For instance, between 1971 and 1978, cable-yarding in these areas accounted for 22 percent of all logging in the middle watershed.

REENTRY OF PREVIOUSLY LOGGED AREAS, 1960 TO 1981

As the value of timber products increased and the supply declined, timber companies increasingly entered previously logged areas to remove residual timber. In the 1960's, this type of harvest accounted for only 15 percent of total logged area, and such harvests usually occurred in areas of substantial residual timber. By the late 1970's, second entry timber harvest accounted for most of the area logged annually, and this logging occurred in areas with smaller proportions of residual timber.

In the upper watershed, the amount of area relogged increased from 29 percent in 1971 to 1978 to 50 percent in 1979 to 1981. In the middle watershed, relogging accounted for 31 percent of the area logged between 1967 and 1970, 49 percent between 1971 and 1978, and 65 percent between 1979 and 1981. Timber harvest in the lower watershed ended with the expansion of Redwood National Park in 1978.

SUMMARY

Logging is the dominant land use in the Redwood Creek basin. Early logging activities cleared the broad flood plains near the coast for grazing and agriculture. Early commercial logging was done by steam donkeys that cable-yarded timber from extensive clearcut tracts of land in the upper slopes of the middle watershed. In the late 1930's crawler tractors replaced steam donkeys as the yarding machines, and partial cutting of timber became the dominant harvest method. The most intensive logging period in the Redwood Creek basin was from 1949 to 1954, and this activity was concentrated in the upper and middle watersheds. During the 1960's, the harvest technique reverted to clearcutting by tractor yarding. It was during this time that timber harvest became most concentrated in the redwood-dominated lower watershed, and logging continued steadily there until the expansion of Redwood National Park in 1978. The passage of the Z'berg-Nejedly Forest Practices Act in 1973, administered by the California Department of Forestry, started a trend to more regulated and smaller tractor harvest cuts and to the increased utilization of cable-yarding systems for timber harvest on steeper slopes. Reentry of previously logged areas to remove residual old-growth timber became the dominant logging activity in the middle and upper watersheds by 1978. The timing and spatial distribution of logging in the Redwood Creek basin indicate that the most intensive logging occurred in the upper basin in the 15 years before the 1964 flood. Therefore, the logging history provides a data base for the discussion of relative effects of logging and major storms on erosion rates.

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