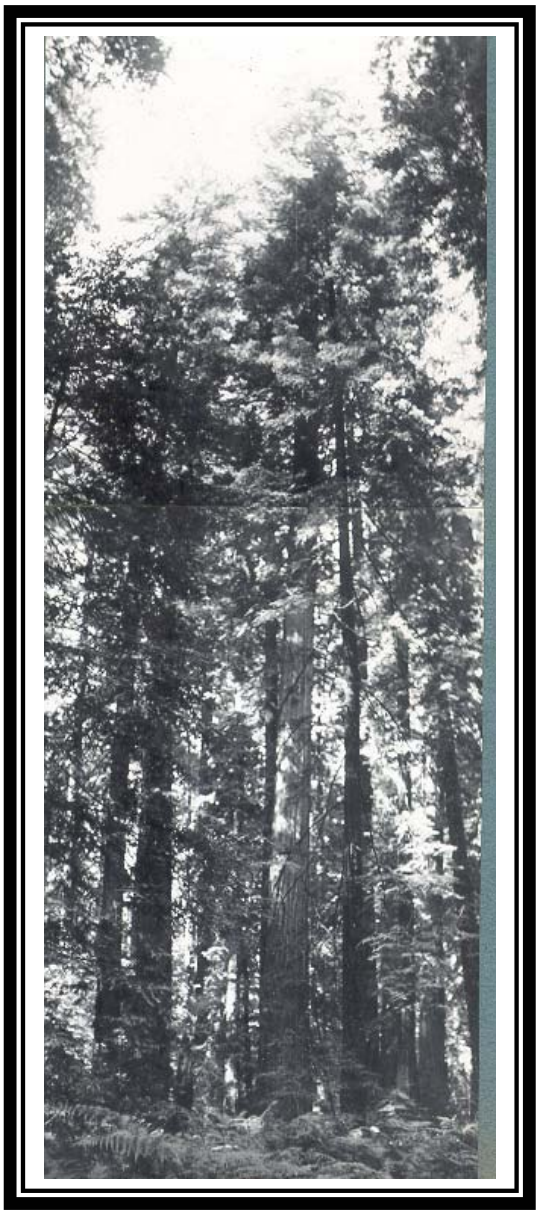
TALL TIMBER AND HIGH WATER

Peter E. Black
June 8th, 1966
Syracuse, New York



Library of Congress Cataloging-in Publication Data

Black, Peter E.

Tall Timber and High Water

Includes bibliographic references
ISBN
1. Coast Redwoods--History--National Park--Eel River Floods
2. Land use--Conservation--Timber Industry--Taxation
3. Recreation--Preservation

This book contains information obtained from authentic and highly regarded sources. Reprinted material is quoted with permission, and sources are indicated. A wide variety of sources are listed. Reasonable efforts have been made to publish reliable data and information, but the Author cannot assume responsibility for the validity of all materials or the consequences of their use.

Neither this book nor any part may be reproduced or transmitted in any form or by any means, electronic of mechanical, including photocopying, microfilming, and recording, or by any information storage of retrieval system, without the prior written permission of the Author.

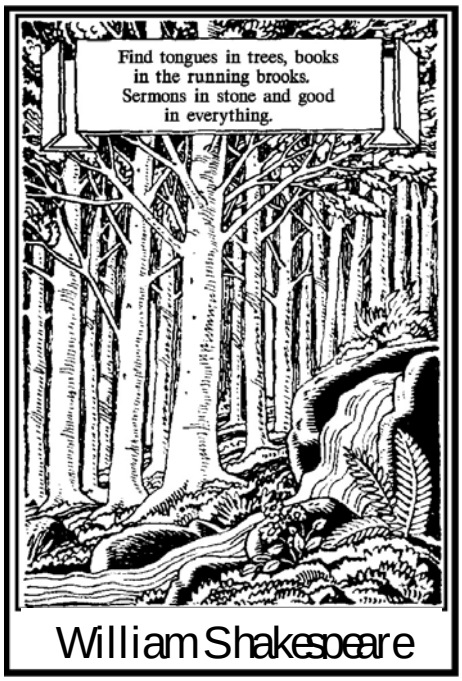
Trademark Notice: product of corporate names may be trademarks or registered trademarks, and are used for identification and explanation only, without intent to infringe.

© Peter E. Black, 2005

FRONTISPIECE: Thirty tons of truck ready to transport about 70 tons of Coast Redwood logs to the mill. On this truck the author rode and first viewed the bases for the conflicts that this book is about. Note two figures next to cab and far right for scale, and fact that the monstrous log loader at the right could be manipulated to turn a log a few inches as well as pick it up.

DEDICATION

To those who can learn from the past
and act in the present
to enhance the future
this work is dedicated



Cover: Coast Redwoods in the Founder's Grove,
Humboldt Redwoods State Park, near Garberville, CA
Above: Antioch Company Bookplate used by the
Author with the quotation's author as it appears in
"As You Like It."

PREFACE[1]

The cotton that I had stuffed in my ears only partially drowned the steady roar from the six-inch exhaust pipe of the off-highway logging truck as it slowly made its way out of the Redwood Creek drainage with a full load of logs. A friend of mine from the mountains of North Carolina had obtained a job with the Simpson Lumber Company and, only shortly after my arrival in Humboldt County, had called and invited me to ride with him on one of his two daily trips to the mill at Korbel. The twelve-foot wide truck had a cab for only one person – the driver – so I rode on the platform outside trying to observe the countryside, enjoy the warm sunshine, and to forget the noise.

We were driving through an area that had been logged in the preceding two seasons, and between the piles of slash left from the logging operation, Redwood sprouts poked through the debris and brush. A large proportion of the soil was laid bare to preparation of beds on which the trees were felled. While I had seen evidence of erosion in a skid trail earlier that morning, I did not see much here: the road had been graded but, as I later learned, the forests soils were fairly stable. Wait till the rains come I thought.

We crested the ridge and started down the long railroad grade that had been concerted to a road in a single weekend and followed the North Fork of the Mad River. The slopes here were steeper and, having been logged long before, were covered with vegetation, a combination of brush and trees. Stream arose from the axles as the driver poured water on the brakes to keep them cool; about fifty gallons were needed for each run to the mill. A driver has a better chance to survive if forgets to fill up his gas tank than if he forgets to take on the necessary water. The rig passed under the bridge that carried US 299 over the North Fork, the highway that linked this rather isolated area with the Central Valley of California, and unloaded at the mill deck.

Back in my car, I drove along the gravel deposits near the Town of Blue Lake on the Mad River, and saw the old wood (Redwood) that carried water from a dam upstream to the taps in Eureka. My head still rattled with the truck engine's roar as the sun disappeared behind the fog that met me as I turned onto US 101, the Redwood Highway, and drove the short distance to Arcata, my new home.

The day takes on more significance to me now, almost five years later: I can only begin to appreciate the relationships between geology and climate and soils and vegetation and water and people to which I was so subtly introduced. The clashes that developed between the latter three, in particular, during the next few years were hardly subtle: they made front page headlines locally, and feature stories across the Nation. A logged area; a park proposal, a Supreme Court decision, and a plan for water development; an argument about a freeway, and a catastrophic flood were involved, each seemingly separate. Yet they are hardly distinct conflicts or problems. Scholars have long recognized the dependence of humans on the environment, and the importance of resource husbandry; but this philosophy has been almost totally ignored in the whirlwind of debris that flew in the wake of these controversies.

I had the good fortune during my four-plus years in Humboldt County to be present when the conflicts appeared, though they had been smoldering for a long time, and I also had the good future to be able to play a major n several of them. That good luck was the result of the kindness of many people to whom I am deeply indebted for their patience with me, but it is my turn now to reflect on what the bits and pieces mean: how they may be put together to formulate a picture; how we may learn from the combination of circumstance, disaster, enterprise, nature, and so prevent, insofar as possible, any recurrence; and how we can improve our relationship with the environment, and better husband our resources.

Peter E. Black, June 8th, 1966

[1] This manuscript was re-typed by the author in 2005 with extensive grammatical editing and some necessary and/or advisable language correction. Wherever substantive changes have been made or additional material has been included, the footnotes so indicate. [PEB, March, 2005]

TABLE OF CONTENTS

LIST OF FIGURES

TABLE

CHAPTER 1

THE EVENTS

In August, 1961, during my first summer in Humboldt County, a colleague took me on a trip to see the Redwood Experimental Forest (then the Yurok Experimental Forest) of the U. S. Forest Service. During that trip, we stopped to see the area that precipitated the conflict between the Redwood industry and the proponents of a national park.

As one drives south between Crescent City and Eureka on US 101, you pass through Prairie Creek Redwoods State Park. At the south end of the Park is a meadow where a herd of Roosevelt Elk[2] may be seen (Figure 2). Then, after a bend in the highway through another grove of the Coast Redwood (*Sequoia sempervirens*) the hills are laid bare by logging (Figure 3). No wonder that this is the proverbial straw that broke the camel's back: after passing through the awe-inspiring park stands and elk herd on beautiful Gold Beach, this logging operation stood out like a very sore thumb, indeed. Arcata Redwood Company owned and logged this land in the summer of 1960 and, because the Coast Redwoods are a shallow-rooted species and are thus subject to windthrow and resultant heavy breakage losses, the Company saw fit not to leave a strip of trees along the road shielding the cut-over area from the public's view. Since US 101 is a major link between the Pacific Northwest and California, many tourists could not help but see this area, just after leaving the magnificent stands in Prairie Creek Redwoods State Park. The contrast was impossible to miss, and the public could not understand it.

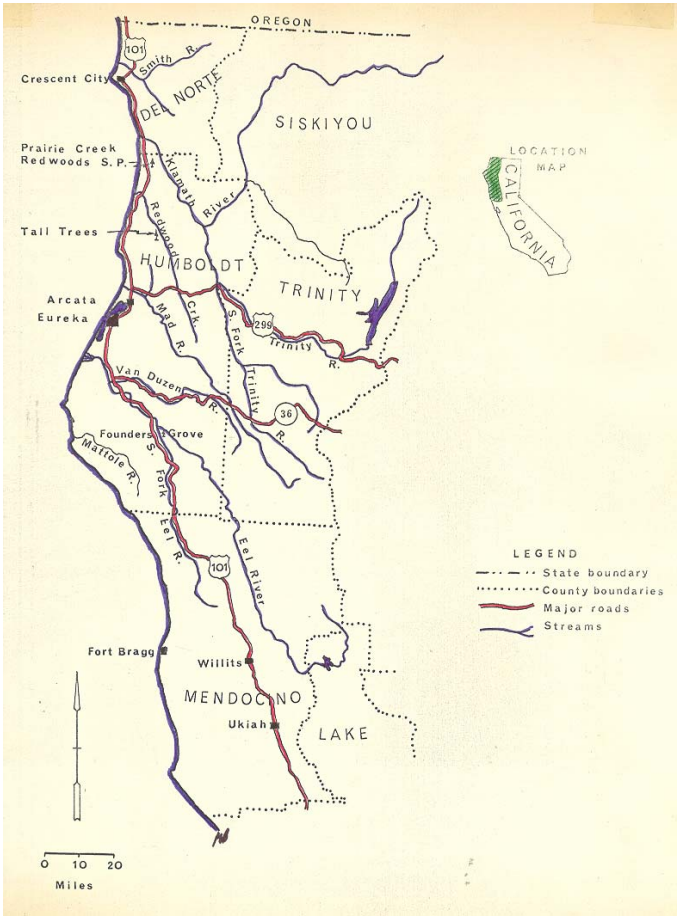


Figure 1 The Coast Redwood region on the North Coast of California. Principal features shown are identified in the text. Map is from the author's report to the National Park Service in 1967.

At the first fall meeting of the Humboldt County Forestry Committee, an advisory group to the Humboldt County Board of Supervisors, a spokesman form Arcata Redwood Company explained to the Committee members and a few spectators what they had done on this May Creek area. As is often the practice, slash was

[2] These were imported from the Front Range of the Rockies between Fort Collins and Denver, Colorado in the 1950s in an effort by the Park Service to save some of the population in the face of what was deemed to be certain elimination by construction by the Bureau of Reclamation of a north-south canal, part of the Colorado-Big Thompson Project, that would block their traditional migration route between winter and summer range.

burned in the later fall, and 580 acres were seeded by helicopter in November. Mention was made of the fact that many tourists had seen the area and the shocked reaction of some were noted: the spokesman asked the Committee if they would financially support a display on the area that would explain Redwood silviculture and management to the public. Not only was the proposal turned down but, as I recall, several of the Committee members were upset that Arcata Redwood had logged so close to the highway and were concerned over the outcome of such practices. Arcata Redwood was told that if they wanted to put up a display, they would have to do it on their own. The following summer, the company placed a sign a mile south of the cut-over land proclaiming a free exhibit ahead and, at the area itself, on what was formerly a landing, a shelter was erected that housed photographs and supplies of pamphlets and brochures. Informative signs were placed around the immediate area, and a forestry student from Humboldt State College was hired for the summer to answer questions for the ten to twelve hours during the day that people stopped to examine, take pictures, and learn. It was a good job of public relations, but one that would have been unnecessary with careful planning of harvesting operations and continued communication with the public. And, it was too late: the damage had already been done. Photographs of the scarred land made juicy grist for the preservationists' mills, and were seen all over the country.[3] The battle of the unique and ancient Redwoods erupted into a full scale war.

During the Cretaceous and Tertiary Periods the species apparently had many relatives and was spread widely over the northern hemisphere: only the Sierra Redwood, or Bigtree (*Sequoiadendron gigantea*) and the Coast Redwood remain. Although the latter reaches the greatest height, the former is known for attaining the greatest girth and volume, and is among the oldest of all living things. But it is the fact that of the two species only the Coast Redwood is of any commercial value that has given rise to the settlements on the North Coast, to the lumber industry, and to the

Figure 2 Herd of Roosevelt Elk on Gold Beach near Fern Canyon.

Figure 3 May Creek. This is the sight that dramatically greeted south-bound tourists after they left Prairie Creek Redwoods State Park initiating the conflict among loggers, tourists, taxpayers, businesses, government agencies, and non-government organizations such as the Sierra Club.

[3] Arcata Redwood Company managed to continue operations (as noted later, they somewhat redeemed their reputation when it was pointed out that they had voluntarily left uncut millions of dollars worth of alluvial old growth Coast Redwoods along the Avenue of the Giants and then deeded the tract to the state for a park), but economics finally caught up with them and as this manuscript was re-typed in 2005, it finally announced that it was going to cut back its operations drastically and there was foreshadowing of closure. [PEB, March 2005]

conflicts between the timber-based economy and those who wish to preserve some specimens of these now unique trees. With the waning of other battles for other threatened resources, both in California and across the nation, the time was ripe for attention to be turned toward the Redwood Region.

A second series of events actually started in the gold fields of California in the middle of the 19th Century, and culminated with a decision by the Supreme Court in 1960. The development of the appropriation doctrine of water rights, wherein the first to divert from the stream and beneficially use the water was the first in right, grew out of the Gold Rush days. It was written into the Colorado Constitution, and was supplied to controversies between states in 1922 in *Wyoming v. Colorado*[4]. As soon as this case was settled, the way was paved for the apportionment of the waters of the Colorado River among the seven basin states. The Colorado River Compact set forth the details of apportionment, including diversion from the river to southern California. Arizona refused to ratify the Compact, and challenged California's appropriation. In 1928, after California had passed a limitation on the amount of water diverted, ratification by six states (including California), approval by Congress, and being signed by the President, the Boulder Canyon Project Act was enacted and Boulder – now Hoover – Dam was built.

Arizona was the holdout, and continued to challenge California in court. The Supreme Court appointed a Special Master to render a decision in the contentious case and, in May of 1960, the decision (which officially was dated 1961) was expected to be in favor or Arizona. California appealed, but lost a 5-3 ruling on June 3rd, 1963[5]. The effect was to impose a restriction on the amount of water California could divert from the Colorado River – water that the state was already using in excess of her 1928 Limitation Act – and, among other things, it meant that California would have to look elsewhere for additional supplies. Upon recommendation of the 1957 California Water Plan document published by the Department of Water Resources, a mammoth plan was already under way to divert water from the sparsely-settle northern part of the state where there is a surplus, to the arid south were most of the population lived and worked and where the strong agricultural activity demanded more and more irrigation water. In November of 1960, the State's voters had approved a 1.75 billion-dollar bond issue, the Burns Port Act, to finance this project. Work was started on various parts of the project, but now with the increased urgency due to the court decision, development, particularly on the North Coast streams, would have to be speeded up by six years or more. By July of 1963, an 888 million-dollar expansion plan was proposed: and Department of Water Resources Director William E. Warne "Suggested speeding up construction of proposed dams on the Eel and Trinity Rivers that would require building the north-south aqueduct bigger than planned so it could handle the extra water."[6] The Department promptly got to work on a North Coastal Area Investigation that was the first water resources investigation of its kind to include anything of any consequence on watershed management in the North Coast area, primarily the Eel River. Indications from this report, which analyzed land use problems as they relate to water resources development, were that the most serious problem anticipated was sediment production from various land use activities which, upon deposit in the soon-to-be-built storage reservoirs, could significantly reduce the storage capacity of the reservoirs and consequently reduce their effectiveness.

---

[4] 259 US 419, 66 L Ed 999, 42 S Ct 552, 1922).

[5] Chief Justice Earl Warren recused himself on the grounds that he was not a disinterested party: he had been the California's Attorney General when the first *Arizona v. California* litigation was brought before the court. Justice Byron White also felt inclined to withhold from participating in the decision since, as a Colorado resident, there was potential conflict of interest.

[6] *Humboldt Times*, July 2, 1963, page 1.

A third series of events led to the proposal for a Redwoods National Park, and had commenced half a century earlier. Efforts to preserve the Coast Redwoods were effectively started in 1918 with the formation of the Save-the-Redwoods League, an organization that had risen over $10 million for the purchase of superlative groves. These trees and the lands on which they stand were turned over to the State to be held in trust for the people of the State. Most of the 27 state parks containing Coast Redwoods are strung out along the Redwood Highway in Mendocino, Humboldt, and Del Norte Counties[7]. Some of them are small and some are quite extensive, and the degree of development varies from virtually none to extensive installation of various facilities: provisions for tourists, campers, and picnickers are particularly good in small groves along the South Fork of the Eel River, where the warm summers entice camping and swimming, and at Prairie Creek Redwoods State Park where a wide variety of nature study, camping, and hiking is available. But the extensive nature of the system precludes effective management either for preservation or recreational use, and interest in a more contiguous land area has been expressed for a long time.

In April of 1963, the National Geographic Society made a grant of $64,000 to the National Park Service to study the ecology and economy of the Redwood Region. The economic study was conducted by John K. Decker, Berkeley, and thee ecological portion was accomplished by contract with a number of the staff, including myself, of the Division of Natural Resources at Humboldt State College. A study of the economy of the timber industry was also undertaken by contract with John G. Miles, Consultant Forester, in Eureka. The reports were to forma a basis for the Park Service' recommendations concerning a park, and the participants were not asked to make recommendations concerning park status; the Park Service would publish a preliminary report, and would follow up with our reports *in toto* as appendices. The preliminary report, labeled as "interim," appeared in September, 1964 and bore little resemblance to anything preliminary[8]: it was finished on glossy paper, with high quality color photographs, and a number of arguments in favor of a park, encompassed by one of three plans designating specific areas, all in the vicinity of Prairie Creek Redwoods State Park, on the northern boundary of Humboldt County. The consultants' reports were not published, and material was abstracted, in many cases out of context and without reference. And, in certain cases, our statements were misrepresented. It was clear that the Park Service had not put its best foot forward, and the hostile reaction with which it was received by the timber industry and the boards of trade and the chambers of commerce and, in fact, by nearly everyone and every group, was logical but as unfortunate as the Service's original report. In the meantime, the National Geographic had published, in July of 1964, a learned article by Dr. Paul A. Zahl on the Redwood Region, including the discovery of the world's tallest trees, which were locate don private lands and therefore, as was obvious to the preservationists, threatened by the wood cutter's nasty axe. The fat was in the fire, now, but the flames were due to grow considerably higher: they were fanned by the controversy over the routing of the 101 freeway around Prairie Creek Redwood State Park.

The steady improvement of access and transportation to and through the wildlands of California means building freeways. Generally the worst bottlenecks are replaced with freeways first,

---

[7] During the summer of 2004, I took time from a trip between Portland and Arcata to drive to and wander on foot through the Jedediah Smith State Park. Words are really inadequate to describe this property. Serene, exquisite, overwhelming, humbling, and almost unbelievable come to mind. None do the park and the nearly one hundred square miles of old growth Coast Redwoods justice. It must be seen close up to begin to comprehend. [PEB, March 2005]

[8] One of the better, subjective review of this report is that adopted by the Executive Committee of the Northern California Section of the Society of American Foresters published in mimeographed form, University of California, Berkeley, December 3, 1964, and reprinted in the March issue of the *Journal of Forestry* in 1965.

although some sections of the Redwood Highway in Humboldt County won't be first class roads for a long time. Logging trucks, as well as long-distance haulers and suppliers make considerable use of the north-south highway, and pressures from the recreation and tourist interests resulted in the proposal by the California Division of Highways to route the new freeway around Prairie Creek Redwoods State Park, at the time a bottleneck that required – and still does require – greatly reduced speeds to maneuver through the closely-spaced giant trees.

Three proposals that differed in their basic alignments were set forth, each with minor variations as well. The first of these, enlarging the existing highway through the middle of the Park was not seriously considered because it still left a long grade and because it would mean cutting some of the trees in the groves held in trust by the State. One of the other alternatives was to relocate the freeway to the east, on a ridge, and outside the Park boundary, but this was objected to by the Division and the truckers as being too expensive, too long and too steep a grade, and potentially subject to extremes of weather, including snow and ice during the winter; and by forest landowners because it would remove productive land from the tax rolls. The third alternative was to route the freeway down to the beach at the north end of the Park, travel along the beach, and rejoin the present alignment south of the Park. The proponents of this alternative pointed to lower grades, and to access to the Park and the spectacular Gold Bluffs, an undeveloped and largely wild beach, adjacent cliffs, and the now well-known Fern Canyon (Figure 4). Opponents maintained that such a road would decimate the beach, be enshrouded in fog, and would result in the exploitation and inevitable despoliation of Fern Canyon. It is also a fact that the beach route would mean cutting some of the trees within the northwest corner of the Park. The furor commenced on April 27th, 1964, in the Eureka municipal auditorium, where 400 interested persons listened and spoke for five hours. The printed testimony filled 162 pages, and there were an additional one hundred pages of letters, resolutions, and so forth. Additional hearings were held that summer in Arcata, but the issues was – or appears to have been – settled by other events.

Figure 4 Fern Canyon

The opposition to the proposed national park that developed, and the vigor with which the beach route was supported, led directly to the formation of a Committee for a Redwoods National Park, later known as Citizens for a Redwood National Park. The first meeting was held in December, 1964, and was chaired by a member of the Sierra Club from Portland, Oregon, although most of those present were local residents. Goals of the group were discussed, along with fundraising methods, merits of the Park Service proposals, and possible courses of action. Officers were elected and several, including myself, agreed to draft a platform. The platform group met December 16th to go over our first draft. The following week saw what might be considered as the culmination of the major events of the period. Because of the resultant furor, I later saw fit to support neither side of the Park issue, attempted to remain neutral and, hopefully, helpful. The event was the major flooding of nearly every stream between San Francisco and Seattle and as far east as Idaho. The "park or payroll" controversy was put on the shelf, but not for long. The 1964 floods were neither new nor sudden and, again, some previous history is pertinent.

For over fifty years, the Corps of Engineers had been interested in water developments on the Eel River, primarily with navigation, harbor development, and flood control at the request of local citizens and according to national laws giving the Corps such jurisdiction.[9] The Corps had previ-

[9] See, for example, the author's book *Conservation of Water and Related Land Resources*, Third Edition, CRC Press/Lewis Publishers, Boca Raton, Florida. 2001. [PEB, March 2005]

ously found no projects feasible. In response to a new Eel River Flood Control and Water Conservation Association request, the Corps again studied the Eel and had held a hearing on a proposal for the construction of levees to protect the delta region from floods on November 20th, 1963. At the invitation of two members of the Country Board of Supervisors, I addressed the more than 600 people present tat that meeting, asking questions of the Corps regarding feasibility of the project. I had my doubts and I let them be known, although I pleaded for some sort of sound flood control.

In the spring of 1964 I was retained by a lawyer representing about 50 citizens residing in the Delta area who did not want the levees; I was asked to review the Corps' proposal. The lack of support for the project on behalf of that many directly-to-be-affected landowners and my and others' reports were responsible for rewriting of the proposal and coordination of Eel River water development projects by the Corps, the state Department of Water Resources, the Bureau of Reclamation, and the Soil Conservation Service. The levees were not built.

Then, on December 19th, 1964, there was much interesting in an eclipse that was to be visible in the area. People were disgruntled when the skies clouded over and obscured any view of it. Far out in the Pacific, the normally-positioned Pacific high pressure system had separated into two parts allowing a series of low pressure systems to move directly on the northern coast of California, Oregon, and Washington. The same pattern had developed on the dame date exactly nine years before, resulting in major floods. The rains started that night and, by the time they had stopped on December 29th, the Eureka-Arcata area was completely isolated except by sea and air. To attempt to cover the details of that Christmas week or to quantify the damages, acts of kindness, or tragedies is not my purpose here; several items, however, must be pointed out. First, the flood was indeed caused by heavy precipitation that was spread out over almost the entire North Coast area: that is, had humans not been present, there still would have been a major flood. It is true, however, that much of the damage that was caused by the flood was inflicted by logs and logging debris carried by the high water. This included breaking of train bridges, knocking down

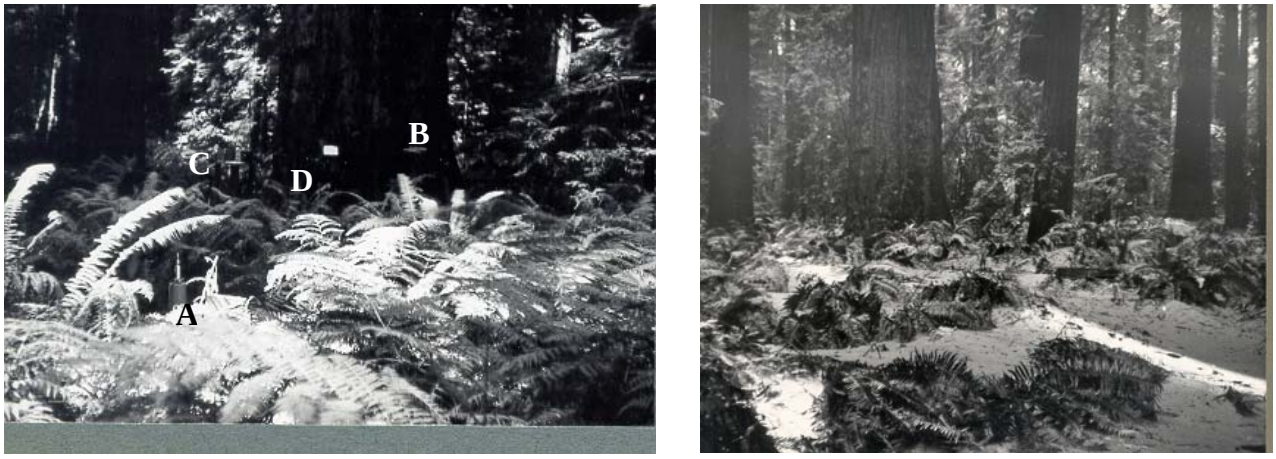


Figure 5 Founders Grove at Dyerville Flat near Garberville. On the left is the site of an intensive study (page 13) of environmental moisture in the summer of 1963. A neutron meter (for measuring soil moisture at points all around the tree to a depth of 5 feet) is at **A;** a max-min thermometer assembly is below **B; C** is a small table holding a hygrothermograph (for recording temperature and relative humidity) and a device that monitors the tree diameter during the 24-hour-long study with the aid of a surveyor's tape around the tree (above) **D**. A man's seated figure – Douglas Jager – may seen just below **C**. **Figure 6.** Same tree after the Christmas week flood showing the deposited silt that is a typical feature of the alluvial environment.

utility poles, and the like. Major floods in 1955 had cased excessive damage, too, and recalled the legendary floods of 1861. Much of the debris and weakened trees were washed out in 1955 and consequently little was left for the 1964 flood flows a scant nine years later. Nevertheless, a prodigious amount of debris was deposited in the Eel and covered the beaches from Cape Mendocino to the Columbia River. There was a tremendous amount of sediment (Figures 5 and 6), too, and not all of it came from managed – or mismanaged – lands.

The waters had barely receded when the charges and countercharges started to fly: logging caused the floods; logging had nothing to do with the floods; if we had had a park, it wouldn't have happened; if the levees had been built they would have contained the peak; grazing is the real scapegoat; and many variations, most of which are not capable of any form of verification. Perhaps the most fantastic charge was that since most of the precipitation occurred on government lands (probably true) and consequently most of the runoff came from government lands (also probably true), that the government was therefore responsible for the flood and financially liable for the downstream damages (Figures 7 and 8).[10]

In the face of these conflicts between grounds an individuals, organizations and institutions, politics and economics, people were confused: the climate was right, and still is, for anyone to set forth an idea, a point of view, an argument, or an attach. A motel owner would find that as a member of the Chamber of Commerce s/he was opposed to a national par but, as an entrepreneur, wanted the tourist trade that would be forthcoming from its establishment. A landowner in the Eel River delta was in favor of government action in controlling floods on the Eel, but opposed to government intervention in land management. An active Sierra-Clubber was in favor of the park, but would have to children to another school because the proposed park would wipe out the school district's tax base. A timber owner was opposed to national part because it would take land off the tax rolls, yet the same thing would happen if the timber were cut under existing law.[11] A San Francisco trucker wanted the beach route because of the economy, but was also a member of the Sierra Club that was in favor of the ridge route. A second-growth timber owner looked forward to a new market for a smaller-sized product with the establishment of a pulp mill, but was concerned over the potential effect of the mill's effluent on a favorite fishing area. Such conflicts of interest are nothing new: they were merely brought into ultra-sharp focus on the North Coast of California during ht early 1060s. The resultant bewilderment and frustration added fuel to the fire:

Figures 7 and 8 Flood damage in the delta of the Eel River

[10] KIEM-TV, Channel 3, Editorial, January 11, 1965. Eureka, CA.

almost any statement could be translated by an interested party (and nearly everyone was) into an argument for or against something, and not infrequently a single argument served both sides. And, there was no small amount of debate about how a short 12-week tourist season could justify a national park or aid in diversifying the economy.

Some of the pressure was relieved by the redwood industry in the spring of 1965 when it issued a carefully thought-out plan for park development that: (1) partially deflated the Park Service/ proposals; (2) answered many industry critics; solved the problem of the beach route, since the private land between Prairie Creek Redwoods State Park and the ocean, including Fern Canyon, was given or sold to the state for inclusion in the Park; (4) provided for the preservation of the tall trees discovered by Dr. Paul Zahl of the National Geographic Society staff; (5) definitely would improve the appearance of the Redwoods to the touring public (not to mention the industry's image), and (6) which had been at least partially put into effect. With the resultant change in land ownerships and park status, the Congress was expected to have rough time evaluating the Park Service/ proposal, not to mention the approximately ten other bills that proposed parks of one type, location, or size in the many parts of the Region.

These were the major events of 1961 to 1965. There were many others: Governor Brown visited the area to confirm the statement that no Redwoods would be cut in order to build a freeway, but an earthquake in Alaska and a consequent tidal wave that decimated Crescent City preempted his time (that same year saw the bulldozers clear a wide through the tall timber north of Redway for the new section of the US 101 freeway there; two typhoons crossed the Pacific Ocean in October of 1962 and blew down about 600 million board feet of timber (in California), which is equivalent to about a year's Redwood harvest (although most of the timber was Douglas-fir); a simultaneous industry-Forest Service battle raged as the former wanted to increase the allowable cut on National Forest lands; and a pulp mill started operations on Humboldt Bay amidst ongoing controversy over (1) how soon the impact of the new demand would be ramified in the woods and the local economy, and (2) there were questions about the impact of the mill's effluent on air and water pollution were – and still are – the subject of controversy.

These, then, were the events I saw and was a part of: they are obviously related, even though certain groups may want to have them kept apart, or may be ignorant of their interrelationships. As an "outsider" I can make some objective observations on the situation: I already have done so at some of the hearings discussed above, in the preparation of the platform for the Citizens for a Redwood National Park, and before the local chapter of the Society of American Foresters. But there is a disadvantage to being objective: I cannot fully appreciate the implications of various actions or events as personally as if I were directly affected by them. These are judgments that residents must make; residents of the state and the nation, as well as residents of the North Coast. The facts are available if people are interested in seeing them in their proper perspective, not under pressure, or emotional campaigns, or via one-sided presentations. It just may be that we can learn something from the events described in time to do something about the future.

---

[11] The land itself would remain on the rolls, but the timber is not taxable when cut. See Chapter 3, the Role of Taxes.

CHAPTER 2

THE RESOURCES

The word "California" carries with it an image of sand, sun, and warmth, as a background for palm trees, swimming, surfboards, and money. The North Coast of the state, on the contrary, has sand, but beyond that bears little resemblance to the classical picture of Sunny California. It does have beautiful scenery and the awe-inspiring trees, and minerals, and hard work, and fog. A more realistic though less romantic picture is in order[12].

Climate

Data on the climate of the North Coast is limited. Only recently have inroads been made into the back country that has resulted in improved communications and access, both of which are prerequisites to adequate instrumentation, servicing, and reporting. The need for considerable additional data is indicated for amore comprehensive characterization of the climate, but it may be generalized as follows:

> Nearly all parts of the State have a wet season and a dry season. This distribution of precipitation is largely controlled by the anticyclone [the Pacific High] that is normally found off the California coast, particularly in summer when the rainfall is at a minimum. Precipitation in winter occurs usually when this anticyclone either is absent or far south of its usual position.
>
> The coast area is marked by moderate temperatures, with small daily and annual ranges, and freezing weather is infrequent on the immediate coast to the northern boundary of the State. In the Coast Range mountain districts, temperature is largely control by altitude and local topography and is much more equable on the western and on the eastern slopes. In the coast valleys the summer days are frequently hot, but the nights are cool.
>
> Along the coast the most frequent wind direction is northwest.

Fog is the outstanding feature of the North Coast weather, generally occurring daily during the summer and not infrequently during the remainder of the year. The Pacific High, which is often stationary for extended periods of time, brings warm, moist air from the central Pacific that releases its moisture upon meeting the air cooled by the cold southerly ocean currents along the coast and by the mountain barriers. Coastal fog frequently lasts until late afternoon, when it finally burns off, and is then replaced by a god bank that often moves in before sunset. A change in the wind direction may not only dissipate the fog, but if the trend is offshore, may keep the area sunny and cool for several days. The air is rarely calm, and the fog is advective, that is, moving horizontally. It generally moves south and east into the river valleys to some considerable distance (Figure 9). Its present is often associated with the range of the Coast Redwoods, but no known causal relationship between the two exists.

Figure 9 Fog in the Mad River valley.

One often thinks of a "blanket of fog," but such terminology hardly does an accurate job of describing its movement and variation, both in thickness and duration. Often, when the fog is thin,

[12] The basis for this chapter is the author's as yet unpublished report to the National Park Service.

scattered sunlight or diffuse radiation may be intense, particularly in the late afternoon when the sun shines underneath the fog layer from a low angle, perhaps even increasing the amount of radiation possible for that time of day. It is generally believed that the fog reduces the total radiation, however, and this may have considerable influence in reducing the combined evaporative type of loss from soil and vegetation, known collectively as *evapotranspiration*. In addition, the fog may play a more direct role in the vegetative moisture regime, as discussed below, especially since, in spite of most people thinking that fog is static, the North Coastal fog moves dramatically and it is only after it has gone as far as temperature and pressure conditions favor its presence, that it stops and begins to dissipate with increasing solar radiation.

According to measurements made on a clear day in August, 1963, radiation on the floor of a pure, dense stand of old-growth Redwoods in the Founder's Grove at Dyerville (see Figures 3 and 4) reached a maximum of one-eighth of that attained in the open. This maximum was attained two hours before and lasted until two hours after the peak recorded in the open. Thus, cooler temperatures and minimum evaporation may be expected with the forest, as is the case elsewhere. Although this great reduction in incident energy is high, it is not uncommon. Because of the scattering of light by fog droplets in the atmosphere, the radiation level at the floor of the stands may actually be higher on foggy days than on clear ones.

The fog and the mountains and the sea all combine to moderate temperatures, especially along the coast itself. Further inland, temperatures in and above the 90's during the summer are common. And, during the winter, it is not uncommon to see snow remaining for a week or more at only a few thousand feet elevation, and only a few miles from the coast. Average January temperatures are in the 40s, and average July temperatures in the high 50s, with the absolute maximums slightly above 100 and the minimums around 12 to 20°F.

Thunderstorms are rare along the coast and along the coastal valleys, and precipitation intensities – the rainfall rate in inches per hour – are generally low. Such low intensities would normally be expected to result in low surface runoff as well as little resultant erosion: however, observations of both floods and sediment indicate otherwise. Persistent rainfall on saturated, disturbed soils, in particular, can yield high amounts of sediment for deposit downstream and transport out to sea.

Only six official weather stations in the Region have records of more than about 30 years, and these show that precipitation along the mountain-bound coast is highly erratic, varying greatly from place to place. It is apparent from these records that distance from the coast has nothing to do with average annual precipitation, which occurs mostly in the form of rain, except (as noted above) at higher elevations. Three of the stations receive about 35 inches, and three others about 75 inches per year. Undoubtedly, precipitation increases with altitude inland, a phenomenon frequently encountered in other mountainous regions. It is interesting to note that the Redwoods on the stream-built alluvial flats in southern Humboldt County probably do not receive excessive amounts of precipitation since they are at relatively low elevations and not on the higher slopes where precipitation may run as high as 100 inches or more per year.

In fact, it is most baffling from the ecologists' point of view how such giants of trees can thrive on what is generally considered to be the minimum amount of precipitation necessary to support forest growth, that is, a total annual precipitation of 30 to 35 inches, or an annual effective precipitation of about 26 inches. Such is the case in Humboldt County and south: the Del Norte Redwoods apparently receive precipitation in excess of these minima. The importance of fog; annual, seasonal, and extremes of temperature; ground water; and soil moisture and nutrient relations all may be important limiting factors in different parts of the Redwood Region.

The distribution of precipitation is such that summers are dry, at least in terms of rainfall. Typically, it does not rain on the North Coast from early June to about October 1st. Evapotranspi-

ration losses are at a maximum during this period, and vegetation must draw on soil moisture in order to satisfy the demand. A calculation of the water balance (based on Eureka climatic data and therefore not necessarily applicable to the surrounding vegetated hills) shows that a significant soil moisture deficit usually begins in late June and lasts until the soil is recharged in late fall or even mid-winter. Along the coast, fog undoubtedly supplements the vegetative water requirement, for both fog drip and energy relations play a role in the water balance.

Fog drip, the result of condensation of atmospheric moisture directly on vegetation with subsequent build-up to the point of saturation of foliage surfaces and drip, is frequently observed. The quantity has been shown to be a significant contribution to soil moisture in many coastal regions around the world. Evidence of fog drip is most often found on (or under) trees that are exposed to the advective (horizontally-moving) fog, either due to the aspect of the slope upon which the stand is locate din relation to the fog-bearing winds, or due to the fact that an individual tree is isolated and subjected to greater exposure. Research by the Aeronautical Icing Research Laboratory (the firm that contracted with the Air Force for research on Mount Washington in New Hampshire) at the Arcata airport – reportedly the foggiest in the world – discovered that different sizes of vegetation (or any substance) have different collection efficiencies and that the small diameter of the Coast Redwoods displayed very high collection efficiencies. Thus, the species is particularly efficient at removing water from the fog. Perhaps more important than direct addition to soil moisture by fog drip is the fact that solar energy must be utilized first to evaporate surficial moisture from the foliage thus reducing the amount of energy available for drawing on soil moisture via transpiration. With fog most likely during the summer, the period of maximum soil moisture utilization and moisture deficit, these relationships become ecologically important.

The equable climate of the Redwood Region assures a cool haven for tourists within the Redwood stands themselves. In addition, the summer tourist season is normally free of rain. The cool, moist climate, however, must be carefully evaluated with respect to placement of campgrounds, picnic, and swimming areas in particular: high atmospheric humidity, low radiation within the stands, and fog drip can make a camping facility most unpleasant and yet these features of the environment appear to be most important in Redwood ecology. Disturbance of these environmental features may be easily and subtly brought about by various types of man-made developments (discussed later) thus potentially destroying the very resource that is being sought. Further, summers are relative short, and fog along the usual travel routes discourages those seeking water environs for recreation, although such areas may be found close by.

Geology and Soils

The rocks, soil, vegetation, and the climate are so interrelated that it is virtually impossible to discuss each separately, yet this must be done insofar as possible in order to gain an appreciation of what each component of the environment has to offer in the way of resources and obstacles to development of the region.

The geology of the Redwood Region is complex of many rock types resulting from a varied and dramatic geologic history. Two major geomorphic provinces are recognized: dominant Northern Coast Range and the Klamath Mountains. The predominant rock type in the Northern Coast Range is sandstone of the Franciscan Groups while a complex of igneous and metamorphic rocks prevail in the Klamath Mountains area north of the range of Redwoods. Volcanic activity plays a role here in soils and watershed topography too.

The nature of the rock and the geomorphic history of the area lend themselves to a rugged topography. In geologic terms and for both geomorphic provinces, the topography is classified as youthful, that is, it is presently undergoing relatively rapid uplift (except for the area in the vicinity of the Eel River delta, which is classified as old age). Overall, the area experiences relatively

frequent earthquakes associated with underlying fault zones. The latter run in a northwest-southeast direction in the Northern Coast Range province and influence both the orientation and shape of the major river basins: long, narrow watersheds predominate, and these are oriented parallel to the major storm tracks, as situation that is favorable to frequent and severe flooding. The geologic history thus influences the form of the watersheds. In the Klamath Mountain province river basins vary in form: for example, the Klamath River watershed is nearly square and in contrast to the Northern Coast Range watersheds runs from north to south before turning west into the Pacific Ocean. This imparts a very different hydrological pattern to that stream from the narrow watersheds further south that coincide with the storm track orientation. Gradual uplift reduces stream gradients where the stream flows into the Ocean, thus the development of flood plains of varying extent are common.

Generally, the geological-time uplift of the west coast in both California and Oregon provide a base level to the rivers and streams that consequently exhibit Most of the river valleys in both provinces are V-shaped, with sharp ridges and steep slopes that cause considerable soil movement. Where the valley floors do widen, extensive alluvial deposits occur. It is on these deposits that the most magnificent stands of Coast Redwood occur where, presumably, an unlimited amount of moisture is available through capillary movement of sub-water table water that assures ample supplies during the period of moisture deficit in the summers.

There is a wide range of soil types and soil conditions in the Redwood Region. As indicated, alluvial soils are present along the main rivers and the upland soils range from young to old soils, the latter being found on the undisturbed ridges where they remain from an earlier era. The upland forest soils are generally classified as belong to the Gray Brown Podzolic Great Soil Group, and are developed from Franciscan Sedimentary rocks. These are the light-colored podzolized soils of timbered regions, developing in moist temperate climates. Generally growing at the relative lower elevations, the Redwood is found predominantly on the alluvial and more youthful soils, on the lower slopes where recent geologic erosion has left little time for soil development. The Gray Brown Podzolic Group has considerable horizon development due to leaching and cycling of organic and inorganic compounds between soil and vegetation, whereas the alluvial soils are without horizon development (azonal). The former are generally shallow, unstable soils, whereas the latter are often quite deep and highly erodible.

Upland Soils

The most important timber-producing soils are the Larabee, Melbourne, Josephine, and Hugo series. A soil series is a group of soils with definitive yet distinct characteristics throughout the vertical section or profile, but differing in the texture of the surface, as the latter is sandy, or loamy, etc. The various factors that act on soil material and result in soil development and consequently series classification are important considerations in vegetation relations and management practices.

The Larabee and Melbourne series often support almost pure stands of Redwood, although Douglas-fir has become established on cut-over second-growth sites. The Larabee is a loam, frequently with a concentrated clay layer that restricts tree growth and wood production. The series also often exhibits a mottled layer, indicated slow movement of subsurface water: this and the relation between the clay layer and tree growth are examples of the importance of water relations in management.

The Josephine (generally inland) and the Hugo series (coastal, with greater fog occurrence) are loams, but they typically possess higher gravel content than the Larabee. Under native cover, all three soils are stable but, following removal of the vegetative cover, erosion is accelerated. The

basic physical and chemical nature of the clayey or heavier-textured soils is such that they are more susceptible to damage when exposed to rainfall without the protection of vegetation.

The Atwell soil series occurs extensively throughout the central Redwood Region and, developing on hard sediments but in association with clay-forming minerals as well, often is the location of considerable erosion due to inherent instability. This soil has a blue-gray clay deposit 3 to 5 feet below the surface and, once disturbed by a road cut for example, will slump and slide for long distances with attendant deterioration of the vegetative cover. A notorious example of this may be seen – and usually is – by travelers along US 101 just south of the Rockefeller Forest on the east side the freeway: highway crews have been working ever since this stretch of the road was opened removing debris that comes down the slopes as a result of the removal of the "toe" of the slope when the road was constructed. The Atwell and its grassland counterpart, the Yorkville (Figure 10), represent the two "problem soils" of the Region. The latter also has a blue-gray clay layer about three feet below the surface and, because it is a grassland soil and clear of natural obstacles[13], is a tempting location for road construction. The result of disturbance in either of these soil types is a large outlay of funds to re-establish stability, which is virtually impossible since they are not naturally stable, as well as disturbance to the natural scene far from the highway right-of-way.

Figure 10 Yorkville soil type displays characteristic convex surface from continual slipping owing to unstable subsurface clay layer.

Other upland soils include a variety of Prairie-like and transition types of soils supporting grass, brush, and woodland vegetation. Sandstones, schists, and shales predominate as parent materials. Infiltration (the passage of water from the atmosphere into the soil) and moisture retention (in capillary pores against the force of gravity) are generally such that a little erosion occurs under native cover. The presence of the Dubakella and Cornutt series (derived from serpentine) under stands of Jeffrey and Ponderosa Pine and Incense Cedar, and the Maymen and Henneke series (with higher proportions of Montmorillinite clays) under scattered stands of Chamise, Chaparral, and Manzanita, indicates a need for concern in management: these soils are relative shallow, particularly the latter two, and have a low moisture retention capacity coupled with generally good infiltration. Such conditions yield a potentially unstable situation, particularly following a disturbance.

The nature of these upland soils and the fact that the vegetation has developed along with them should lead to better management. Such understanding should promote sound use of these pro-

[13] The Atwell is a forest soil. The clay layer is a Montmorilinite clay that slips readily and retains moisture well, the primary cause of the instability. Attempts to engineer a solution are usually fruitless.

ductive resources and develop an appreciation of the value of the resource in meeting essential human needs. With sound management we may be able to limit economically and environmentally damaging erosion, sediment, and flood problems.

Soils of the Flats

The alluvial soils of the Region are not as yet fully classified, although considerable investigation regarding their properties, nutrient, moisture, and vegetation relations is currently underway. Generally classified as silt loams, more than 90 percent of the soil material in these deep deposits is silt-sized. With such high silt content, water may be brought up from considerable depts. By capillary movement layering due to frequent flooding is apparently common, with one set of observations to approximately 30 feet at Bull Creek Flat on the South Fork of the Eel River exhibiting fifteen distinct layers dating back approximately one thousand years. Obviously, repeated flooding has played a part in the history of the Redwood stands that grow on these alluvial soils. Emanuel Fritz reported that the excavated roots of living trees show that new root systems were developed as the old soil surface was covered with flood-deposited sediments.

Excessive leaching of the soils of the Region has left them notably free of lime and slightly to moderately acid, as well as deficient in soluble salts. Perhaps the important implication of observations of nutrient-deficient soils under Redwood is that regeneration from seedlings. The species has apparently adapted itself to low nutrient conditions, and root development is restricted by excessive nutrients, with the exception of soluble phosphorous. The latter is present in greater amounts in the alluvial soils than in other California forest soils, and is apparently directly correlated with root content. Nitrogen, on the other hand, is lower in Coast Redwoods than in other species: about 11 percent of this element is in the tree itself, with more occurring in the bark and foliage than usual, and less occurring in the wood.

Perhaps the greatest management problems on alluvial soils are (1) controlling bank-cutting, which is the result of increased runoff from logged and otherwise disturbed waters where runoff waters can concentrate more quickly and thus contribute to higher flood peaks, and (2) compaction of the soil surface and consequent impairment of root functions as a consequence of recreational use. The former is a particularly severe problem at Bull Creek Flat and has been the object of considerable field work and the subject of much controversy. Because of this and similar experiences, a case may be made for upland and upstream control to aid in the preservation of the superlative alluvial stands. This was, in fact, the thinking that led to the stand taken by Park proponents that an entire watershed should be included in a National Park to adequately protect the alluvial stands.

Compaction of the soil in which the small feeder roots of trees are located causes damage to the trees. The extent of the damage, however, of the ability of the natural vegetation to withstand or to recover from such damage is not entirely known. Observations by Meinecke in 1929 provided ample evidence for him to say “that continued and concentrated traffic compacts the soil to the marked and serious detriment of the roots and that the effect on the soil is a lasting one, so that quick recovery of the roots is not to be expected.” These observations were not substantiated at the time by examination of the bulk density (the volume-weight) of the soil under different types of use but it is, perhaps, unnecessary to resort to expensive and time-wasting measurements, for the results are quite obvious in many cases. Certainly the bulk density of the forest soil is increased – becomes more dense – with tramping. Such increases may be expected with heavy vehicular or pedestrian traffic, with the latter often being worse owing to the exertion of greater pressure per square inch by humans than draft animals. Generally, unless the soil is first plowed and subsequently trampled, compact is a phenomenon that does not extent to great depths. Since the majority of a Redwood’s feeding roots are located near the surface, however, where they ob-

tain air, moisture, and nutrients, even limited compaction in the surface inches may cause extreme damage. Trampling not only compacts the soil, but also directly kills low vegetation, such as ferns, removes litter, and results in restricted air and water movement by reducing infiltration capacity and pore space.

Flooding of the alluvial flats often creates a condition where the trees mush generate new feeder roots near a new, elevated surface. Thus, new roots may be generated when the existing environment becomes hostile, either by flooding or compaction. If the entire area around a Redwood is compacted, however, a loss of vigor may be noted and trails located in the Founders' Grove, for example, have had to be moved. On the other hand, certain trees show no loss of vigor even after prolonged trampling and compaction , or following installation of pavement completely surrounding the tree[14]. Generally, however, trails and roads only pass by one side of a tree and under such conditions the effects may not be serious, although avoidance of such access locations is recommended. The roots of Redwoods may extend over considerable distances; thus location of trails or rods anywhere may have unexpected consequences. The resulting loss of vigor may not only be considered a threat to the preservation of the stand or of individual trees themselves, but the potential creation of dead tops may present a safety hazard as well.

Compaction of soil, then, has three effects. First there is a direct killing of the roots by excess pressure on the roots. Second, there is a reduction in the aeration of the soil. And third, there is a decrease in the water available to the tree roots by (1) a decrease in the infiltration capacity of the soil surface, and (2) a decrease in pore space in which water may be held and maintained available for plant growth. In the soils on which the Redwood grows, where relatively high clay contents prevail, compaction can be a particularly serious problem because the damage is likely to be greater on such fine-textured soils.

State Park practice is to utilize wood chips (often Redwood) to protect heavily-used trails, the visiting public, and the surrounding environment. Such practice reduces the amount of compaction along the trail, and tends to keep people on them where they are less likely to sink into mud, and to remain on the trail itself instead of wandering through the stand at random destroying vegetation directly as well as by compacting the soil.[15]

The nature of the soil, its ease of compaction, and the delicate balance of micro-environment of the Redwood all preclude extensive recreational developments *within* the groves themselves. Such development as can be accomplished should be limited to trails only, and there should be well marked and protected. The more intensively used recreational developments should actually be *outside* the main groves, in places where visitors won't disturb the trees, and where the micro-environment provides a more pleasant recreational experience.

In these areas outside the groves, soil-vegetation survey maps (available from the California Division of Forestry or the University of California) represent an up-to-date, standardized inventory of soil and vegetation conditions that reflect the symbiotic relationship between the soil and its soil-forming factors. These are not only useful to the professional forester, agriculturist, or horticulturist, but to the recreation planner and the public too. With this information it becomes relatively easy to avoid the location of permanent installations or the construction of roads on the

[14] This could be because pavement spreads and drastically reduces the pedestrian weight per unit area, thus not affecting compaction. The potential for reduced infiltration with pavement is, of course, much more drastic, but collection of surface runoff from the pavement may infiltrate at the edges and be sufficient to preclude loss of vigor. [PBE March, 2005]

[15] With the growth in environmental awareness on the part of the public – especially those who are likely to stop and visit Redwood parks – the use of "Please remain on the trails" signs is more acceptable and effective. [PEB March 2005]

Atwell or Yorkville soils, for example. Such planning assures a greater degree of control over land slumping, accelerated erosion, and siltation of lower stream channels, as well as a greater degree of permanence of installations. A thorough understanding of the soils leads to more efficient utilization of the vegetation, whether for timber production or recreational planning.

Vegetation

Lush vegetation is the prevailing feature of the North Coast landscape: native species include Madrone, Tanoak, Laurel, Sitka Spruce, Douglas-fir, Western Hemlock, and Coast Redwood are immediately apparent as one views the hillsides. There is a continuous mosaic of soil and vegetation complexes on the slopes, including grasslands, brush, and forest of all patterns and shapes, related to topographic position, micro-climate (usually considered as the lower three meters of the atmosphere), parent material (rock and/or soil material), and past land use. But closer examination reveals many additional species of trees, brush, forbs, and grasses. Many detailed works on the abundant and associations of species are available: it is primarily the Redwood with which we are here concerned.

Growing in a narrow belt (see Figure 1) about 450 miles long between the southwestern corner of Oregon and Santa Cruz in California, the Coast Redwood reaches its optimum development in Mendocino, Humboldt, and Del Norte Counties and is one of the fastest growing species in the Nation. The 1- to 30-mile wide zone (in many places) immediately adjacent to the coast is associated with coastal fog and the Humid Transition Life Zone, characterized by relatively high humidity, nearly uniform year-round temperatures, and many species of vegetation.

During the Cretaceous and Tertiary Periods the species apparently had many relatives and was spread widely over the northern Hemisphere: only the Sierra Redwood, or Bigtree (*Sequoiadendron gigantea*) and Coast Redwood remain. Although the latter reaches the greatest height, the former attains the greatest girth and volume and is the among the oldest of living things. But it is the fact that of the two species only the Coast Redwood is of any commercial value that has given rise to the settlements on the North Coast, to the area's lumber industry, and to the conflicts between the timber-based economy and those who wish to preserve some specimens of these now unique trees.

Figure 11 Modern methods for protecting falling giants involve bulldozing a series of cushions made from local soil.

The Redwood is a prolific seeder, and although a majority of the seed produced is not viable, that is, will not germinate, there are still enough produced to completely cover a bare road bank with seedlings like a lawn. The question remains, however: "Will they survive?" Given the right amounts of sunlight and moisture – and the all-important microrhiza (fungi that assist tree roots absorb water from the soil) – they will. But the natural forests have not been reproduced in this manner: rather, the Coast Redwood reproduces primarily by sprouts that usually are produced when a tree is dis-

turbed in some way, such as being blown over, cut, or damaged. When that occurs, remaining roots and stumps send up sprouts that have a large root system already established and which grow with great rapidity. Even fallen logs and branches contain enough moisture and nutrients to support a healthy sprout that may even survive to take its place in the mature forest. Since the ability of the grown tree to generate new roots is known, and the possibility of root grafting is present because the tree can reproduce vegetatively, it is perhaps impossible to assess the percentage of old-growth stands that actually did develop from sprouts[16]. It as been pointed out that the number of sprouts per ace is insufficient to re-stock a cut-over area following logging, but it is often forgotten that the percentage of survival of sprouts is much greater than with seedlings, and consequently an area may be almost completely restocked sprouts, although invariably some seedlings will be included.

In the early days of logging the Coast Redwood young trees were felled in profusion to provide a soft bed for the large tree to be dropped on, thus protecting the brittle wood[17]. Selective cutting was prevalent when oxen were used for skidding logs, and clear-cutting was practiced with the entrance on the logging scene of the steam donkey engine, which gave rise to much concern over future productivity. Such practice probably did not disturb as much of the soil as originally thought except for those areas along the down-hill skid trail, and the roots or stumps of cut trees were disturbed or possible scarified just enough to promote good sprout reproduction. The introduction of the track-laying tractor allegedly permitted the return of selective cutting, supposedly a "good thing" but only if it does a better job of providing for the future, not it is exploited for "high grading." With the heavy bulldozer, which can and usually does go almost anywhere, stumps and roots are scarified a little too much and the soil disturbed to a far greater degree than with former methods and, while sprouting still occurs, the land must be re-seeded to assure re-vegetation with a commercial species. In modern times, too, the stumps are actually removed to meet the demand for burl. Since the Redwood seed is low in viability (apparently due to the triploid number of chromosomes that make successful sexual reproduction unlikely), and foresters have been so uncertain about the capability of seed to regenerate the forest, the companies have in large part re-seeded their cut-over lands with Douglas-fir and Sitka Spruce, a fat that has been cited by and is most distressing to the Redwood preservationists[18].

Nevertheless, much land is coming back to Redwood and the slopes that a few years ago were covered with Red Alder, which invades the site after clear-cut logging, now show Redwoods that have slowly made their way through the dying canopy of the short-lived species and produce a healthy second growth forest. Such lands will be capable of harvesting in less than 100 years – probably around 70 to 80 years – and, as more and more second-growth stands appear, the relationship between annual growth and annual cut for the Region will improve. A virgin forest produces no net growth: it is the goal of management to harvest the mortality of the forest before it becomes a loss; to keep the stands of timber producing their maximum number of board feet per acre per year. That is the basis of *sustained yield*, harvesting the income on the capital, not the capital itself. Thus, as the virgin stands are removed, they are converted into second-growth and the mounting productive capacity of these forests will soon equal the annual harvest. There is,

[16] An interesting exercise is to stand in a alluvial grove of virgin Coast Redwoods and consider why the trees are standing where they are: one may ask "How are they connected to neighbors?" Have these trees developed when an old giant was blown down and the stump sprouted this circle? How many generations of trees back do the trees in this stand represent?

[17] The accompanying splintering that occurs from such a crash landing is ironic because the Redwood is the wood of choice for stadium seats because it weathers well, even without a finish, and doesn't produce splinters.

[18] Another factor is forest land taxation, discussed in Chapter 3.

however, an unknown in the case of the Redwoods: it is the rich-colored, resistant heartwood that makes the lumber of the old-growth trees so valuable as commercial timber, and it is not known with certainty how long it takes before a second-growth tree – even a sprout – begins to produce this heartwood. This is not to say that the lighter-colored sapwood does not have value: it does, but the demand for it may not be as high as for the heartwood with which everyone is familiar, nor does it have the deposited elements that render the wood able to withstand rot and insect attack. The unknowns in some of these biological, management, and economic questions are sources of controversy.

Perhaps one of the bigger areas of misunderstanding centers around acreages of Redwood lands. The figures have been used by anyone wishing to prove a point and are often confusing, to say the least, because they are not fully documented, or are cited out of context, or presented as part of an emotional argument with little regard for factual background. Obviously, Redwood acreage may be broken down into numerous categories: of the original approximately two million acres of Coast Redwood, some of it has been cut over and some has not. Of those lands that have been cut over, some of the lands are still in forest production, either Redwood or some other species, and some are not. Practically all of the land of the North Coast was forested prior to settlement commencing in the mid 19th Century. No much of these former forested lands support farms and pasture, freeways, municipalities, and suburbia. The lands that have not been cut over may divided (as may those above) into government and private ownership, some of which may be logged and some of which have been earmarked for preservation. It is pointless to attempt to cite the actual acreages here: the present threat of a national park has caused timber harvesting operations to speed up in recent years and data quickly grow obsolete[19]. But it should be pointed out that the old proverb about figures not lying but liars being able to figure holds true: the timber industry states that about 50 percent of the virgin stands are already in government ownership[20]. The park proponents state just as emphatically that only about 2 percent is in government ownership. Both statements are true! The former is quoted in reference to *existing* virgin stands, and include some Redwood Park acres that don't grow Redwoods as well; the latter is in reference to the *original* Redwood acreage. The statement has even been made that, without the government purchasing or taking over any additional Redwood lands, in ten years the government will own about 80 percent of the virgin stands. This statement is, of course, also true, but only because industry will be cutting remaining virgin stands on their own properties and consequently reducing their percentage. In the face of such elusive arguments, it is no wonder that confusion has reigned. That old-growth Redwoods' continued existence is threatened is a subject for debate; that the species is threatened with extinction is false.

Ye another actor enters the picture: as mentioned generalized acreage figures include small patches of land that do not support Redwoods. Openings in the forest, stands of other species, and other types of areas are intermixed with Redwood stands, particularly on the upland sites where the tree grows in association with other species in contrast to the alluvial flats where it grows in almost pure stands. Except as a general guide, acreage data cites as bases for arguments for or against additional (or les) preservation, cutting trees to locate freeways, and so on, are patently unproductive. There is probably enough (a difficult word to quantify but easy to use) acreage now reserved to satisfy those who wish to see Redwood protected that so that future generations

[19] In retrospect – almost forty years of it – my desire back then had, I'm sure, been fueled by not wanting to devote precious time to running down data; data that would undoubtedly change in both the long and short run. I'm glad I didn't! [Black, March 2005]

[20] One of the redeeming stories to come out of the Redwood Region is that Arcata Redwood Company paid taxes on hundreds of acres of old-growth alluvial Coast Redwood stands for nearly a century and then – without cutting the trees – gave them to the state for inclusion in a State Park, the Avenue of the Giants.

will be able to visit the species. But this acreage is not physically consolidated into one manageable unit and, in view of the lack of knowledge concerning the relationships between the trees and the supporting microenvironment that may be easily disturbed, a lower limit on the acreage that must be set aside if we really intend to assure adequate preservation is not known.

We speak and hear of an ecological entity being necessary in order to assure preservation, but what is an "ecological entity"? Ecology may be considered as the relationships between an organism and its environment; it encompasses everything in that environment, and thus the word "entity" is superfluous. Since water plays such an important role in the ecology of the Coast Redwood, perhaps the watershed – the natural unit of land that contributes runoff to and is formed under the influence of a single stream – is the proper unit to which our attention should be directed.

Hydrology

Streamflow is the result of integration of all the factors influencing the movement and storage of water in and on the watershed. It is the symptomatic pulse of the climate, soils, geology, vegetation, and land use. Under careful observation, the behavior of streams can yield much information regarding history, management, problems, and development.

As discussed above, periodic flooding is a natural part of the ecology of Redwood sites that are located on the alluvial flats along rivers of the North Coast. The occurrence of floods is a function of a great number of variables, among the most important of which are soil depth; vegetative cover; precipitation amount, intensity, and frequency of occurrence; size and shape of watershed; orientation of the watershed with respect to direction of storm movement (if consistent); and, of course, the degree of flood control measures on the stream and its watershed.

Generally, the soils on the lower slopes in the Redwood Region are deep. However, on steep slopes where soils are normally thinner, the water-holding capacity of the soil is insufficient to retain unusually large volumes of precipitation. During the long, dry summer season the native gestation draws on soil moisture in order to satisfy transpiration demand. The soil horizons dry out starting in late June or July and continue drying until the fall rains dependent upon the aspect of the slope and fog occurrence. The first of the fall rains goes to replenish the soil moisture stored in the capillary pores (retention storage). Only after that deficit is satisfied does the increasing streamflow reflect a moisture excess (via detention storage). A particularly large fall storm, then, will ordinarily not produce as much of a flood peak (if any) as will the same magnitude of storm that occurs after the soil moisture deficit is satisfied. Thus, the soil not only acts as a reservoir of water for plant growth and a source of gradual runoff, but also with the aid of the vegetation, is a regulator of flood-producing rains.

Ina study conducted in June, 1963, depletion of soil moisture during the summer was found to be most rapid for second-growth stands of about 40 years of age, and considerably less rapid for old-growth and second-growth stands in excess of about 80 years. Land that had been cut over immediately preceding measurement showed the lowest rate of depletion, except in the surface 3 or 4 inches where evaporation desiccated the unprotected soil. This actually means that soils under relatively young, second-growth stands have the greatest flood control capability since they have the greatest moisture storage capacity; at least until the soil recharge in the fall is completed.

If the vegetation is removed and not replace, recharge of the soil will take place earlier during the fall rainy season, and consequently there will more and higher flood peaks. Such has been the case on Bull Creek, although the problem is accentuated there by the nearly circular shape of the watershed, which helps deliver water more equally from all parts of the watershed to the outlet.

Only restoration of the water storage capacity of the watershed can rectify, in part, the flooding and consequent sediment problem that has been observed there in recent years since harvesting the old growth. Re-vegetation need not be with Redwood to restore the flood-control function of the soil: any deep-rooted vegetation will accomplish this, and many species that exhibit characteristically deeper roots may be even better-suited than the relatively shallow-rooted Redwood. It is, of course, desired to have re-vegetation accomplished with ac commercial species in preference to brush, but in certain cases, any vegetative cover is desirable and certainly preferable over none at all.

Removal of the Redwoods has often led to annoying problems of excess moisture: even on upland sites and particularly on north-facing slopes where lower energy translates to reduced removal of soil moisture via evaporation and transpiration, harvesting operations have left a site moist enough to support Red Alder stands. Along US 101 north of Crescent City a cut-over stand of Redwoods is now a wetland, and on lands now used for subdivisions, springs appear in the middle of streets and lawns were none reportedly existed prior to the land use conversion.

Precipitation, the source of the soil moisture and streamflow, is fairly evenly distributed during the rainy season, from September or October to May. Intensities are normally low since convectional (thunderstorms) are rare and the typical cyclonic disturbance is not greatly influenced by dramatic thermal gradients. Such regiment o delivery of water to the watersheds is less conducive to flooding than a few, high-intensity storms of large precipitation volumes. Often the flooding that does occur is the result of warm rains on snow that has accumulated at the higher elevations, or the result of an unusually intense storm following a prolonged rainy period that has completely recharged the soil. Rain, however, tends to yield higher peaks than a like amount of water content as snow because more of it is immediately available for runoff in contrast to a snowpack that developed under cold conditions and must await warmer temperatures before melt and runoff can occur.

The degree to which the storm covers the watershed also has an effect on flood peak magnitude, such that small watersheds, which are more likely to completely covered by a storm than large ones, will yield higher flood peaks in terms of runoff per unit area; total volumes may be less than large watersheds, however. Even when a storm completely covers a larger watershed, peak flows will be lower because of the ability of the watershed temporarily to store or detain excess moisture in ground water aquifers and the stream channel, and because not all portions of the watershed concentrates the storm runoff into a peak at the same instant. A measure of how the watershed concentrates the stormwater into a flood peak is called the *time of concentration* and, although variously defined, it is essentially the time between the start of precipitation and the flood peak.[21]

The size and shape of the watershed affect the time of concentration: the generalized shape of most of the North Coast streams is narrow and elliptical, a shape conducive to a short time of concentration, especially if the storm moves toward the outlet, that is, down the watershed. This (as mentioned earlier) is the case for most of the North Coast streams oriented SE/NW by fault lines. With the cyclonic storms approaching from the west, the initial rain development (on the leading eastern edge of the disturbance) is out of the south or southeast. The combination produces the majority of rainfall-induced flood peaks. The time of concentration is usually shorter on smaller watersheds and, although each small sub-watershed of a major drainage basin normally

[21] Other definitions include the length of time it takes for a drop of water from the farthest point on the watershed (from the outlet) to reach the outlet, and the length of time between start of hydrograph rise and the occurrence of the peak flow. Where ground water does not occur and the watershed is small enough to be completely covered by a storm, the several definitions tend to converge.

has a time of concentration different from its brethren, if they all were to contribute to the peak from the parent basin at the same time, the results would be disastrous. Such is usually not the case since, as the watershed size increases, even if sub-watersheds were alike, the likelihood of a storm covering the entire contributing area at one time is low and, in addition, resistance to runoff delays delivery from large watersheds to the outlet. Watershed shape affects time of concentration: the almost circular shape of Bull Creek watershed leads to high flooding potential because all parts of the watershed can contribute to a flood peak almost simultaneously since the distance to the outlet from all parts of the watershed is short and similar in all directions. Thus, our hindsight tells us that the vegetation should never have been removed en masse from such a steep-sloped, thin-soil, and circular watershed. Can we keep from repeating the error? Yes, if we anticipate the problem and can identify the factors that contribute to the potentially troublesome areas. Land use also affects local runoff and storage configurations and, consequently, the time of concentration is dependent upon land use, too. Prominent among the impacts of land use on stream flow in general and flood peaks in particular, is the removal of vegetation.

These relationships between watershed and stream behavior illustrate that (1) the streamflow reflects watershed conditions, and (2) that what may be poor practices on one watershed many not be poor practices on another. We may also infer that under certain conditions we may be able to alter the watershed conditions so much that complete restoration of equilibrium is impossible. And example of this may be found on Price Creek a fourteen square mile tributary to the Eel near the delta. This area is underlain by blue-gray (clay-laden) shales and was logged and subsequently grazed. Several quarries contribute to the stream's high sediment load, but even on the abandoned slopes the soil continues to erode. It would be impossible to utilize even small engineering structures on the land without creating more soil movement. Torrent control measures in the upper stream channel itself may be the only feasible action short of abandoning the area to re-stabilize at a considerably lower base level. At present periodic storms wipe out the channel-shaping and debris-cleaning work on which the county highway department spends taxpayers' dollars.

There are, at present, no flood control measures on any of the North Coast streams, although a few water supply dams do aid in reducing flood peaks simply because of their inherent storage capacity. As discussed in Chapter 1, plans for the lower Eel River have been proposed, but these do not strike at the source of the problem and are only flood *protection* measures, not flood *control*. As such, they do not reduce the amount of water flowing from the watershed, but only confine it to a channel of lesser width with the attendant disadvantages. In the words of Barrow Lyons "To date, however, the principal effect of flood control works … has been the creation of bigger and better floods."[22] Only a large, or series of many lesser dams with sufficient storage capacity *and* an operation procedures can alleviate the damage downstream.[23] But all the structures that can be built cannot adequately dot he job unless the soils can fulfill their role in flood control and at the same time be protected excessive erosion by raindrops. From this we may infer maintenance of good vegetative cover, but we may not infer that no vegetative cutting should be done. Under good forest practices we expect that land will be bare for from one to seven years following harvesting operations, even with re-establishment of vegetation, but so also may the soil's ability to store floods improve. Cut-over areas should be limited in size, but they also must

[22] Barrow Lyons, 1955. *Tomorrow's Birthright*. P. 143.

[23] In laboratory research I performed years after I wrote that sentence, I placed various combinations of large and small dams on a sponge-covered Styrofoam watershed model under a rainfall simulator and discovered that one large dam downstream on the watershed did, indeed, provide slightly more flood peak reduction than five smaller headwaters dams. (Black, P. E., 1972. "Flood Peaks as Modified by Dam Size and Location," *Water Resources Bulletin* 8(4):780). [PEB, March 2005]

be spread out so that a number of them won't be in a position to contribute simultaneously to flood peaks and stream sediment loads.

The production and transport of sediment in North Coast streams is a natural phenomenon. The lower reaches of Redwood Creek, for example, are filled with sediments as a result of submergence of the V-shaped valley below sea level following the last ice age. When the river flows encountered the higher sea level or, more generally, flows encountered the *base level*, the velocity of the water was slowed and sediment could no longer be suspended. Layered deposits, representing different sized particles that dropped out according to flow velocities, covered vegetation that grew along the banks and logs or, more correctly, whole trees that had been undercut from the upstream banks and floated down only to be stranded and buried. Following the extreme flows in December, 1964 much of this sediment was eroded and the vegetation was exposed and, in some cases, finally floated out to sea along with more recent debris. The continued sediment load is also natural: where the land is undergoing uplift, the downward movement of water is a normal erosive force. As vegetation dies and slash from logging accumulates and brush temporarily invades the site, wildlife can denude the landscape and leave the soil further exposed to transport downstream.

But human activity can increase this production and transport of sediment. Harvested forest land leaves areas with no vegetation, particularly in roads and skid trails. In the Redwood Region even more land is left exposed as a result of the preparation of the layouts for the brittle trees to be felled on (Figure 11). If revegetated, the visual effects of logging may not last for long, although it is generally observed that only a small proportion of the total logged area actually produces sediment. This may be controlled by careful planning, location, construction, and maintenance of roads, and effective post-harvesting measures on skid trails and layouts. Control over the capricious use of the bulldozer can play a major role, in fact that very piece of equipment may be beneficially employed to restore conditions conducive to low sediment-producing areas following harvest with little expense and effort, along with the long term benefits.

Because of their inherent productivity, forest lands may foul a stream with sediment for even less time than abused grazing lands. The latter are very prone to both the temptation of overuse and to consequent continued erosion and sediment production. Active gullies produced as a result of overgrazing may persist long after the cattle or sheep have been removed from the area because the relatively low productivity of natural grasslands cannot regain its grasp on the natural balance of water movement and storage.

Figure 12 Tributary to the Eel River Conley Creek in 1963, and **Figure 13** in the spring of 1965 following the 1964 floods. Note Richard H. ("Pete") Hawkins standing on the same rock

It is probably the more intensive uses of land incurred by humans that yield most of the sediment over and above that which is normally produced. Roads are notable offenders, slicing through the slopes that are too steep or retain their stability with a portion of them removed, straightening or diverting stream channels in an effort to straighten adjoining roads, and so on. The relationships between stream discharge, amounts of sediment load and particle sizes that can be transported, and channel morphology are intertwined, complex, and difficult to obliterate with most affordable engineering structures. That's why examples of stream control failure are easy to spot. Two examples on the North Coast are noteworthy, but hardly unique. A short distance up the Van Duzen River its confluence with the Eel, the highway (California 36) is located about 80 feet above the river bed on the north side of the stream. As the highway rounds a river bend, the road fill was deposited for a short distance into the channel: this small diversion of the current was sufficient to throw the main current against the opposite bank, undercut it, and result in a massive slide on the south side of the river.

Another example is on the Smith River, in Del Norte County, where US 199 is on the southeast side of the river and follows a long sweeping bend known as Drinking Fountain Curve: here the highway engineers cut into the cliff on the opposite side of the river in order to move the stream to the northwest and thus straighten out the channel and the curve. In the floods of 1964 the water respected no works of mere humans in reverting to the old channel and wiping out that portion of the new road and with it a considerable investment.

Not only is the steady source of sediment from "geologic erosion" evident, but even excessive amounts are known to have natural sources, that is, with no apparent help from humans. Several natural slides were observed following the heavy rains, as much as fifty inches in ten days that produced the 1964 floods. The before- and after- scenes at the same site on Conley Creek (Figures 12 and 13) present a graphic example when one considers that the watershed lands upstream of this point were unmanaged. It will take a long time for these areas to re-stabilize and to reduce the sediment load to that was formerly considered as "normal."

The sediment is important to human's activities in the area not only as a site for the magnificent Redwood flats, but also is of importance to migrating salmon. Gravel beds are the prime spawning grounds of these anadromous fishes, and deposition of find sediments can smother the eggs deposited thereon. Suspended sediment also increases stream temperatures and plays a role in the balance of light and food for the various aquatic inhabitants. Many of the coastal lagoons are isolated from the sea each year by the deposition of sediments in bars across the mouths of the streams as a result of slow-moving waters at times of low flow. The flood peaks serve a vital function here in that there is created sufficient velocity and volume of flow to open the bars and establish communication between fresh and salt water environments for the migrating fish (Figure 14). If the water supply dams proposed for the streams are build and operated without regard to this important facet of the hydrology of the North Coast streams, the storage and consequent reduction of flood peaks may preclude the opening of some of these lagoons, and even ensure that some of them will close that heretofore have not done so. Note that the typical timing of flows that exceed

Figure 14 Flood flow has breached the sand and gravel bar that precluded flow from lagoon to sea.

bank full capacity – the definition of a flood – occur on the average of every two to three years, with a common interval of 2.33 years. That most assuredly is ecologically linked to the period of time that the anadromous fish remain in the ocean, also two to three years, before returning to the stream in which they were spawned to repeat the life cycle[24].

As ascertained at Bull Creek flat, deposition of sediment within the alluvial Redwood groves is a natural occurrence. The high silt content associated with such alluvial soils offers a high retention capacity for tree growth and, located only slightly above the water table, provides the trees of a plentiful supply of water though upward capillary movement. Results from an intensive study made during the summer of 1963 at the Founders' Grove indicate that the Redwoods may be rather sparing in the use of water, a conclusion that would fit with the observation these giants grow in an area of minimum annual rainfall necessary to support forest growth, typically 30 inches per year. It is also apparent that these stands, at least, may have as much water located above ground in the trees themselves as there is the soil profile where the roots are located. Small wonder that harvesting the Redwoods results in swamping and the appearance of springs!

An Intensive Soil Moisture Study[25]

This purpose of this study was to evaluate the removal of soil moisture during a typical fog-bound day in summer. An extensive array of neutron meter access tubes (Figures 5 and 13)were established and allowed to equilibrate before the actual data collection in June of 1963. Around the 6.5-foot diameter tree (shown in Figures 5 and 6), twelve five-foot long aluminum tubes were inserted and fitted with a rubber stopper at the lower end to preclude water from entering. Between measurements the tubes were capped on top to preclude water entering as well. The distribution of the tubes is shown in Figure 15. Additional instrumentation included wind, temperature and humidity, and solar radiation measurements within the stand, outside the stand in a nearby opening, and at a height of about 30 feet in an open log truck loading structure left standing from previous harvesting operations. A make-shift dendrometer (for monitoring the diameter of the tree) was set up by threading a surveyor's tape solidly away from the foot-thick bark with screw-eyes into the wood; the tape was anchored at one of the screw-eyes and was draped securely (so it would not slip) over the sensing wheel of a standard water level recorder, held taught by a weight. If the tree expanded, the pen would show an increase in diameter on the standard 24-hour paper recording chart. After considerable adjustments to ensure a believable record, the dendrometer recorded the change in tree diameter shown in Figure 14, along with all the other data collected.

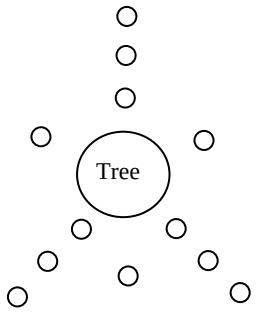


Figure 15 Tree and neutron meter access tube locations

A full five feet of soil moisture data were to be collected from all twelve tubes at the beginning and end of the 24-hour period, and every two hours during the period the surface and second

[24] The last three sentences in this paragraph were on my mind as I wrote the first part of the paragraph, but I didn't articulate this inference until well after the original manuscript was drafted. [PEB, March 2005]

[25] The study described in this section was not included in the original 1966 typed manuscript. It is reproduced here and now because it throws some additional light on the ecology of the Coast Redwoods, and was never published, although it is in the archives of the University of California Coast Redwoods Project, and a summary was presented at a meeting of the American Geophysical Union in Seattle in December of 1964, just after the floods. [PEB, March 2005]

foot's moisture content was measured to see if the impact of fog deposition on the tree might be detected in the soil around the primary feeding roots.

The measurements (Figure 16) were started as planned at 7 AM, but there was no fog. In fact, Northern California newspapers the next day noted the occurrence of the strongest temperature inversion ever recorded and, in fact, the three temperature/humidity (hygrothermograph) records showed the passage of the inversion as it rose during the period. As is often the case with anecdotal and non-replicated studies, the unexpected conditions were a blessing in disguise, for it taught more about Redwood ecology than anticipated, reported in the following description:

> The conclusions were that the water in the tree settled during the period as moisture tension at the canopy level decreased during a strong temperature inversion; evidence is in the higher soil moisture levels in percent by volume in the first foot at the end of the period than at the beginning; in the continuing increase in moisture content in the second foot; and in the short recorded period of steady diameter expansion. The transpiration draft on soil moisture shows a lag of about 4 hr. This is considerably more than is to be expected if one assumes that the maximum transpiration will occur at Local Solar Noon. That is when conditions of maximum light intensity and minimum relative humidity occur; transpiration rate is further influenced by the age of the leaves, moisture stress, and wind movement (Kramer and Kozlowksi 1979).
>
> The observations were made on a rather unusual sunny day in the Redwood Region which included a strong temperature inversion, under which condition the flux of atmospheric moisture is downward.[26] The upward flux of moisture on the more typical foggy days when there is no temperature inversion would be restricted by the high relative humidity. Under either set of conditions, there is not a strong gradient along which the water is likely to move, and the redwoods appear to "conserve" water, thriving in an area of only about 35 in. to 40 in. of precipitation per year (Black 1964).
>
> The interrelationships between radiation and transpiration, especially when considering the individual leaf, are complex: When leaf and air temperature are equal, re-radiation and transpiration dissipate the entire heat load. If stomatal closure stops transpiration, the heat load must be dissipated by re-radiation and sensible heat transfer, but usually there is a dynamic equilibrium in which all three mechanisms operate (Kramer and Kozlowski 1979).
>
> The magnitude of the water stored in vegetation is, no doubt, considerably less in stands of other species. The principles would apply, however, even though instrumental detection and statistical verification might be difficult. Thus, it is important to conceptualize the more complete environmental moisture when investigating and managing the forest vegetation. This phenomenon of vegetation effecting a direct increase in soil moisture has recently been reported elsewhere; this research was reported in Richards and Caldwell (1987) and Caldwell and Richards (1989). Here, deep-rooted vegetation brought water up from below the zone of aeration in response to vapor pressure gradients during daylight hours and, upon diminution of the gradient at night, the water in the vegetation was "released" and flowed out into the aerated zone, therefore increasing the soil moisture content.

The quoted text (above) summarizes the conclusions drawn from the study: they tie in well with other studies of soil moisture, and explain some phenomena that otherwise wouldn't have been clarified. This study is an intriguing one in part because it was one of a kind, and in part because it completely missed the conditions under which it was undertaken. What was learned was invaluable.

---

[26] Fog prevails a great deal of the time and has been perhaps erroneously, identified as the limiting factor in Coast Redwood distribution (Fisher 1903); frost is more likely (Roy 1966). [Footnote from the text – see FN 27.]

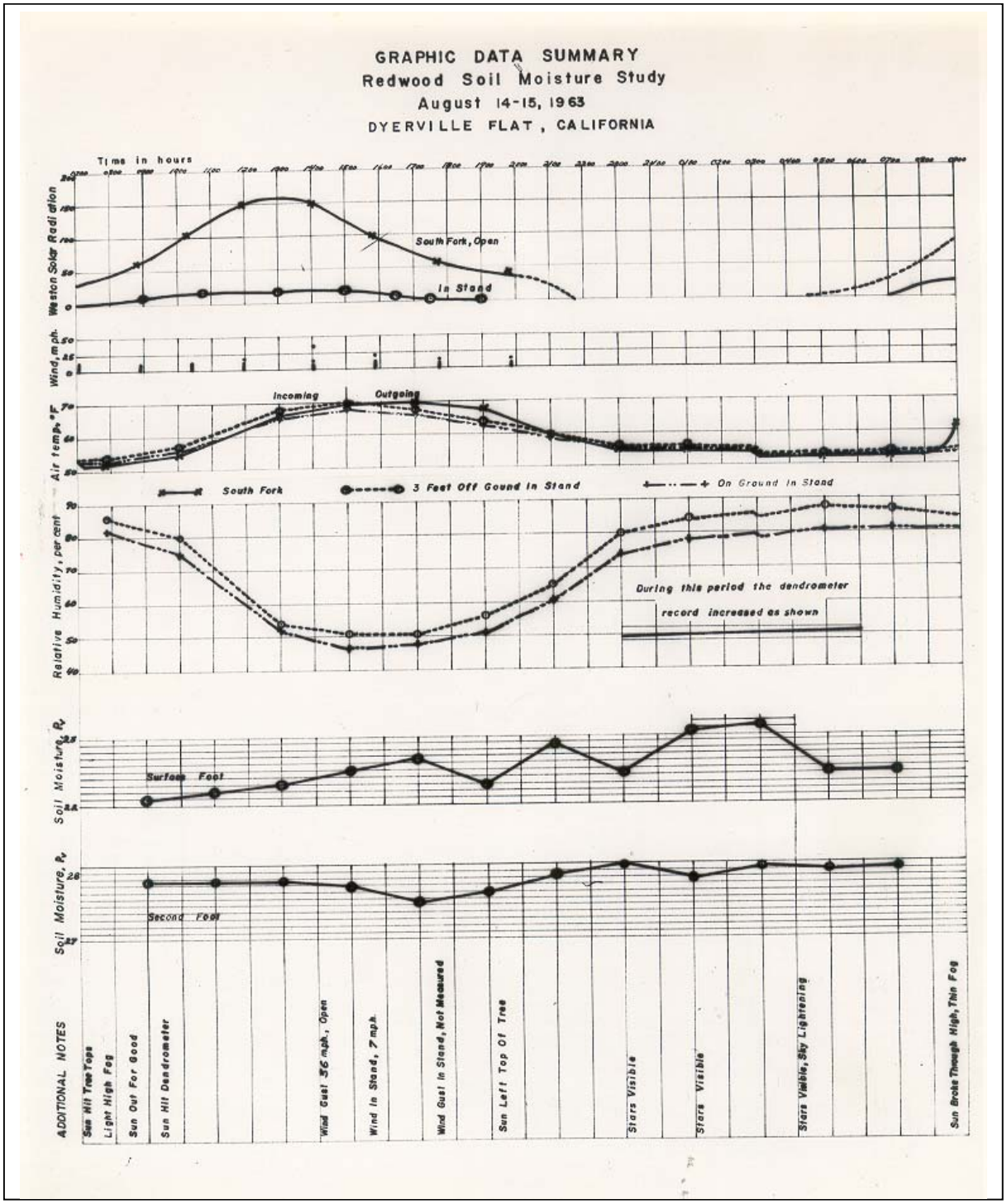


Figure 16 Twenty-four hour study measurements at Founders' Grove, Dyerville Flat.

Into this environment, we have already sent the inroads of human's activities: in fact, much of what we have learned has come about because of disturbances humans has made. But, in order to assess more fully the potential solutions to and to solve the problems of the North Coast, it is necessary to examine in more detail the various segments of human endeavors in the Region.

SUMMARY

The evidence points to the conclusion that the Redwoods are rather frugal in their use of moisture, although a great deal of it must be present to sustain growth. It was this analysis of moisture and other relevant environmental factors that led the author to recommend consideration of the watershed in the report to the National Park Service (Black, 1964) as a basic and important unit of land management, as follows:

> The climate, soil, and vegetation of a forest stand have been recognized to play an interacting role in the survival and regeneration of its inhabitants, and this concept is no less important in the case of the Redwoods. The nature of the hydrologic cycle and how it influences (or is influenced by) behavior of precipitation, temperatures, parent rock and soil properties, and stream and ground water behavior appears to be unusual in the Redwoods. The differences from what would normally be expected are ramified in the apparent conservation practices of the species with regard to soil moisture, and the important roles of fog and ground water in minimizing moisture utilization.
>
> Expanding this concept, it is evident that the watershed is similarly an ecologic unit with definitive characteristics and conditions that are favorable for Redwoods in most cases. Consideration of flood flows, watershed orientation, storm movement, and the texture, nutrient, and moisture relations of upland and alluvial soils indicated that the species depends not only upon its immediate environment, but on the entire land unit that lends its characteristics to those of the stand.
>
> Interfering with the natural micro-environment of the stand, or with the stream flow, slopes, or other features of the watershed which, if disturbed, upsets the equilibrium of the stand or stands must therefore be avoided. This is a particularly complex problem to resolve in that the narrow Redwood belt crosses the downstream end of each of the North Coastal rivers (except the Mattole and the Russian). Control over the management practices on the lands upstream is necessary, but need not be accomplished by outright ownership: cooperation in management is more desirable and may be more effective.
>
> It is concluded that management for the preservation, use, and development of old-growth, second-growth, and regenerable[27] stands of Redwood must be continuously concerned with both the micro-environment of the stand itself and the nature and problems of the watershed in which the stand is located, and that coordination of management of the various resources throughout each watershed under consideration is essential.

[27] In most cases in this manuscript's *general text* I took the liberty of correcting misuse of terms, eliminating sexist language, changing hundreds of "which" to "that" and shortening sentences or eliminating flowery (and non-existent) words. In this *quotation* from what is now an official government document, however, I made no changes (other than capitalizing "Redwood"), so I must apologize for the amateurish lack of sophistication in the written word(s). [PEB, March 2005]

CHAPTER 3
THE LAND IS USED

HISTORY

The fog-bound, tree-covered coast between San Francisco and Oregon was seen as early as the middle of the Sixteenth Century by Juan Rodriguez Cabrillo and Sir Francis Drake. It was, at that time, of course, already settled by Native American tribes who had come over the land bridge at the end of the last ice age and spread out over what is now the Americas.[28] Perhaps even earlier, Chinese and Russian adventurers and fisherman explored the coast while seeking fishing grounds, but there is little indication of exploration of the inland areas even though Spain and England both laid claims to it. The Russians first settled in 1769 and, in that same year, the Spanish Missions were begun at the southern end of the State, the line of them pushing northward, but only to San Francisco. The first historical mention of the Redwoods was also made that year, by Fray Juan Crespi, the Franciscan missionary in the first European land expedition up the coast. Thus this, as well as the 1776 discovery of the Redwood at what is not Palo Alto all took place south of San Francisco Bay. The wild country of the North Coast was not yet explored.

The Jedediah Smith Expedition traversed the North Coast area between 1826 and 1828 on a northward-bound trek and, not long afterwards, in the 1850s, mining operations in various parts of the Coast Range commenced. Valued, of course, was gold, but later mining operations included chromium, manganese, and other minerals. Utilization of local woods were used for mine timbers, railroad ties, flumes, and water pipe and conduit. Redwood sidewalks built over one hundred years ago in Eureka may still be seen, and some of the original water supply system is still in use although it is slowly being replaced.

The La Grange Mine, an example of one of the early mines, may be seen along highway 299 in Trinity County. Abandoned in 1918 except for a few small subsequent workings, this mine produced 3.5 million dollars in gold between the time it was first operated in about 1862 and its closure. In the process, 29 miles of ditches and conduit were constructed in to develop a head of 650 feet so that water delivered to the monitors could effectively move the gravel. In all, about 100 million cubic yards of material were moved, and the effects of this operation still offend the eye, for only a few patches of vegetation remain on or are beginning to return to this abused land. Strip mines, cut-over timber lands, and borrow pits were the first inroads on the wilderness, though the few scattered Indian tribes that inhabited the Region before the arrival of the white man allegedly burned the high prairie areas for pasturage and agricultural production.

The latter half of he Nineteenth Century saw the rise and decline of the timber economy in the Lake States pine country and the center of timber exploitation moved west across the plains after visiting the South. Douglas-fir, the species that bears the greatest burden of the nation's timber economy, was not to be exploited until the turn of the Century, by which time somewhat better forest practices precluded the widespread destruction that occurred in the eastern and northeastern states. The word of the value of the Coast Redwood spread and, limited to a small area and with its particular characteristics, the demand for the wood grew rapidly. Aside from its intrinsic beauty, the wood was and is most highly prized for its ability to withstand rot, insect attack, and

[28] Sentence added to earlier manuscript as any reference to Native Americans had been omitted in ignorance in 1966. [PEB, March 2005]

fire. In contact with the ground it needs no treatment, and the growing wine industry's demand for grape stakes and storage casks, and the demand for railroad ties and other products provided work for woodsmen, money for the Region, and opportunities for business. The fact that it does not produce splinters combines with its ability to withstand weathering make it ideal for picnic tables and other outdoor furniture, and for stadium seats.

The pattern of development involved primarily small mills, cutting on land that was owned outright and, following cutting, the lands were abandoned or sold. Considerable acreage reverted to the State as a result of fraudulent mining and homestead claims. Consolidation of land-holdings resulted in the formation of large enterprises that changed hands and names frequently and, in certain cases, were purchased by or made subsidiaries of large, nation-wide and now internationally known firms. The land presented a devastated appearance to those who viewed it following logging, but regrowth by sprouting soon restored a green, if considerably shorter cover. The shift in methods of logging from

THE TIMBER ECONOMY

the use of oxen to the steam donkey (introduced in the later 1880s) and to the track-laying tractor (introduced in the mid-1930s) has changed the management practices, the nature of the regeneration, and has result in economies of scale that favor the large land-holding firm with integrated mill, both owned by one management.

Until the completion of the Northern Pacific Railroad between Willits and Eureka in 1915, lumber was shipped from Humboldt Bay by sea. The Mad River Railroad operated north and east out of Arcata on the north end of the Bay and brought logs and lumber from the woods and mills: trains were run out onto the Bay on trestles and loaded directly on ships, or routed overland to San Francisco markets, for shipping rates via rail were kept competitive with sea rates to that and other destinations even though rail rates to intermediate points not accessible to the sea were higher.

Although first exploited for fold, the land has since been exploited for timber, managed for timber, and now supports the timber industry which, dependent on how measured, contributes from 30 to 70 percent of the Region's economy.

No matter how one views the North Coast, timber is apparent: whether from the air, the sea, or of course, the land. On the highways logging and lumber trucks shake the ground and, in the atmosphere the smoke from scores of mills pierce the sky. In the night, the glow from the sawmill burners dot the landscape and the logged slopes and the maze of logging roads are clearly seen from the air. The newspapers each week may have an entire page devoted to matters of concern to the timber industry, and articles pertaining to it appear almost daily. Truck and equipment repair and parts supply houses, as well as the sawmills, border the highways and, for those who miss all this evidence, US 101 is signed as "The Redwood Highway," and billboards advertise the existence of the timber industry.[29]

The economy is timber-based. The 11.2 thousand persons employed in lumber and woods work represent 30 percent of the total manufacturing employment o\in Humboldt County as compared with only 7 percent for the State as a whole, and this is three times the number employed in the same category by its nearest rival, Mendocino County. Region I of the State Planning Office, including Del Norte, Humboldt, Siskiyou, Mendocino, and Lake Counties has 37 percent of the

[29] I re-write this 1966 paragraph knowing full well that life has changed dramatically since then. I have visited the North Coast on three occasions in recent years and am well aware of the changes, but left the paragraph to convey the impression of the time. [PEB, March 2005]

State's commercial forest land, 45 percent of the saw timber volume, 43 percent of the growth and, for the period from 1953 to 1959, 54 percent of the annual cut.

The products of this activity are lumber, plywood, particle and composition board, and pulp to mention the major ones. Historically, there has been a nation-wide shift towards remanufacture of the raw material so that marketing of secondary products (lumber) occupies a lesser proportion of the total sales. Man has been unable to duplicate or find a satisfactory substitute for the basic material, but by re-shaping, treating, cutting and re-forming, and various other processes he has been able to offer better and more useful products.

I watched while the headrig at the Pacific Lumber Company in Scotia sawed a giant Redwood log into beautiful six-foot-wide planks, thirty feet long, and then gasped in horror as those planks of heartwood were decimated in the gang and trimmer saws into little pieces. I know that the small pieces when end- and side-glued into a large board are more stable dimensionally and more useful for such things as piano sounding boards and caskets, but surely there must be other ways in which to make the latter product and save the limited number remaining large Redwoods that are to be market for uses worthy of their quality, and not buried in the ground! This same mill, incidentally, practices particularly full utilization of the tree, either producing Presto-Logs from the sawdust or utilizing it along with other waste as fuel to produce stream to run the operation instead of just eliminating it wastefully in a burner; produces insulating material from the bark; and is continually experimenting with new products and uses of the wood itself.

In addition to direct timber harvest and lumber manufacturing, much of the local employment is in direct service to the lumber industry: repair, sales, and service of trucks, saws, tractors, loaders, and other woods equipment; radios, vehicles, office building materials and hardware for the mills, mill offices, and public use. Transportation of primary and secondary forest products is itself a big industry, and the trucks that ply the highways pay no small amount of taxes. Motels, gas stations, commercial transportation, professional, retail, and wholesale business must also be included, as must the government services of police, fire, administration, and schools. It is perhaps impossible to place an accurate figure on the amount of these activities that are directly dependent upon the timber industry, or that would be eliminated if wood products were suddenly no longer available because they were locked up, although that is frequently a way to begin to arrive at an estimate.

The economics of timber management is faced with three major difficulties: first, it is often noted that the tree represented both the factory – the wood-producer – and the product itself. Second, there are many "externalities" involved in the management of land for timber production, considerations over which the logger or even the timber owner may have little concern unless public pressure and/or government regulations restrict his activities. And, third, unlike agriculture, growing a forest crop takes a long time and thus entails a greater risk, particularly because of changes in market conditions during the time of production including fire, insects, and disease. These are virtually universal, but overriding all of these, and varying from county to county, state tot state, and region to region, is the role of taxes.

In order to stem the tide of ruthless exploitation of forests, the Internal Revenue Code was amended in 1944 to include the profit realized from the sale of timber held for more than six months [sic!] as a long-term capital gain. This enabled the timber owner to qualify for a lower tax rate than would be the case on straight corporate or personal income. In 1963 it was suggested in the President's message to Congress that this be changed. Since California as a major lumber producer would be directly affected, a study was made of the timber economy by Dr. John Zivnuska of the University of California for the State Office of Planning. This excellent report is commended as a sound body of material for analysis and review of the industry. It is impossible to specifically summarize all the detail of this report here, not is that the intent: in order to provide

some background for further discussion, pertinent information has been abstracted and is included in this section and elsewhere.

There was no general provision for withholding of withdrawal of public lands of public use prior to the passage in 1891 of the Forest Reserves Act. By this time, much of the timbered lands on the North Coast of California had been claimed under various homestead and railroad grant acts, and was in private ownership. The higher, less accessible lands along the North Coast were later withdrawn and set aside as National Forests, with the result that ownership of timber lands is in large part stratified according to timber type: the government, by and large, owns much of the pine and Douglas-fir lands at the higher elevation; small (less than 5,000 acre) and medium (5,000 to 50,0000 acre) holdings are concentrated in the Douglas-fir lands; and most of the large holdings (more than 50,0000 acres) are in the Redwood lands.

The acreages of commercial forest land in various ownership classes, in millions of acres in 1960 for Region I and the entire state are as shown in Table 1. Notable differences are in the higher percentage of federally-owned lands, and the lesser percentage of acres held in small and medium parcels for the State as a whole, particularly in view of the gradual transfer of lands from small to larger holdings within the Region. Between 1953 and 1960 almost 0.4 million acres in Region I entered the large class, from 0.81 to 1.20 million acres, with corresponding declines in medium and small holdings. Further back, the 1.66 million acres in small holdings in 1953 were owned by 7.7 thousand owners, but only four years previously they were held by 9.7 thousand owners. In 1953 5.5 thousand of these owners actually owned less than 180 acres each.

Table 1 Commercial Forest Land in Region I and the State of California.

Ownership Class	Region I	State
Private acres:	3.33	8.06
50,000 +	1.20	3.44
5,000 – 50,000	.69	1.11
5,000 -	1.44	3.51
Public acres:	3.01	9.26
US Forest Service	2.57	8.57
Other federal	.29	.50
State and local	.15	.19
Total	6.34	17.32

Such a small amount of land is difficult to manage for timber on any sustained basis. The long period of production and the requirement of the logging substantial areas at one time to operate economically precludes conservation in management: the land must either be used for some other purpose or cleared of timber and sold.

Avoidance of the State Forest Practice regulations can be accomplished, in part, by filing with the State a conversion permit that specifies that the land that now grows timber is to be cleared and used for some other use, for example, grazing. Under such conditions the regulations to not apply: the timber may be cut in any way desired, slash and logging debris may be left on the ground, the area need not be reseeded, and roads and skid trails need not conform to standards,

and so on. These lands, if not converted in fact, are still counted as commercial forest land, but are actually nonproductive wastelands. On 64 percent of those lands for which conversion was applied prior to 1956 the operations were incomplete or abandoned! If the land, on the other hand, is capable of good production, or can round out large holdings by sale, it becomes a part of the larger holdings following sale. As a consequence, not only do the smaller holdings remain scattered and thus difficult to manage, they are also lower in productivity.

Basically, however, the North Coast timber lands are more productive than other State commercial forest lands that occupy 37 percent of the land and 45 percent of the timber volume. In 1960, the Region's saw timber volume was estimated at 152 billion board feet, of which 52 percent was in private holdings and 48 percent in public: the trend is opposite in all nine other regions. Between 1947 and 1959 the annual cut in Region I had increased threefold, from 1.26 to 3.79 billion board feet. Most of this increase was in Douglas-fir, but the harvest of Redwood has also increased, though not as great proportionately. At these rates of harvest, simply arithmetic will provide anyone who pursues it with an estimate of how long it will take to cut the remaining old-growth timber, with those estimates varying from 6 to 20 years or more. Such variation is natural due to the difficulties in defining old-growth timber and timber lands; in measuring it and determining intent of owners to harvest, sell, or use the land for purposes other than timber production, and in determining the trends of transfer of lands from one owner to another, a practice that affects management plans.

Annual cut has leveled off and even declined since 1959 and, in face of this, restriction on the growth of the timber-based associated industries has brought about a recession, particularly affecting the North Coast counties.

Zivnuska predicts a further decline in the annual cut by 1975, an event that will further undermine the North Coast's timber-based economy. This decline will be most seriously apparent on small and medium holdings because of the lower productivity and management problems, thus resulting in further transfer of lands to large holdings. As the remaining old-growth timber is cut, the lumber industry will have to shift to handling second-growth, notably of smaller size and perhaps without heartwood. With greater and greater re-manufacturing processes, it becomes less necessary to have secondary manufacturing plants close to the source of the raw material, and consequently new plants utilizing North Coast timber and wood products may located nearer the points of use than the points of supply, that is, outside the Redwood Region. Transportation is an important factor here, too, favoring the location nearer the place of use. Bust, as the second-growth stands mature, the present imbalance between cut and growth will diminish and, as has been the case in each forest region of the United States and in the country as a whole, the growth will soon exceed the cut.

The role of taxes, however, is of prime importance to the timber industry, indeed to the populace of the North Coats as a whole, and has a great impact on timber management, withdrawal of lands of preservation, and the well-being of the Region.

THE ROLE OF TAXES

The taxes that are pertinent here, of course, are the real property taxes imposed annual on the timber lands. As a carry-over from an agriculture-based economy, the taxes are collected annually in order to pay the bills that the various branches of country, state, and federal governments expect to incur. The three requirements of a good tax base are that it be dependable, predictable, and large to ensure sufficient income to the government.

The taxation procedure involves first, ***assessment*** of taxable property with the governmental jurisdiction, including recording and adjustment through civil and court claims; second, ascertaining the ***tax levy*** on the basis of budgets from the various governmental departments for the coming fiscal year; third, determination of the ***tax rate*** arrived at by dividing levy by assessed value; and finally, ***collection*** and subsequent distribution of the tax monies. This is the idealized framework within which taxing governments should work, but there are sufficient points of flexibility to allow considerable leeway in operation procedure. Since there is often a ceiling on the tax rate and because the assessed value is usually lower than the market value, fluctuations in the levy may be easily accounted for by adjustment in the assessed valuation, thus keeping the tax rate the same from year to year, a feature desired by taxpayers.

The presence of tax-exempt lands within a taxing government unit creates problems, particularly at the county level where such inclusion is likely to have a greater effect than it does on a state. On National Forest lands timber sales provide a source of income to the county and local governments within whose jurisdiction the forest is located by specifying that 25 percent of the revenue from timber sales be turned over to the state and county governments for roads and schools[30]. The amount collected, therefore, is obviously determined by the amount harvested, limited in turn by the allowable cut and to what extent the amount thus made available from federal lands can compete with timber cur from private lands. If the allowable cut is low, *in lieu* payments are low and more the local tax burden falls on private land-owners. The recent fight over the level of the allowable cut reflects – and at the same time conflicts – with the role of private taxes on timber lands. The allowable cut on National Forest lands is geared to the annual growth and, as old-growth stands are cut, the annual growth increases. Generally, the allowable cut is too low (although actual cut is even less than this) and, to preserve their own timber stands, private firms sought to raise the allowable cut to permit a greater supply of timber for market to combat low-priced, competitive imports from British Columbia and the Far East. However, in the Redwood Region, keeping private timber growing merely raised the potential taxes those same firms would have to pay and, in the midst of the battle with the federal government, the 1962 blowdown occurred, thus making even more timber available for and further depressing the market. Furthermore, since the Coast Redwood has unique properties, wood products from other species may not readily substitute and compete. Clearly, this is not a trivial problem!

To make matters even more complicated, in addition to the problem of tax exempt lands, there are problems that are incurred as a result of imposing a real property – *ad valorem* – tax on forest industries. Such landed firms consider their lands or their forest stands as income-producing units of their manufacturing structure and thus compete with firms of similar size located in urban centers where the income-producing units may include depreciable machinery and physical plants. In this way an inequity arises in that the trees may be taxed as an income-producing unit of production as well as the unit of production. And another inequity is evident when it is remembered that normal income-producing machinery is taxed at a decreasing rate as it depreciates, but the tree is taxed at an increasing rate as it grows and the wood becomes more valuable owing to its size and, for the Redwood, the greater proportion of the wood in heartwood thus the tax based on assessed value doesn't give an adequate measure of income productivity. Further, a firm with land in two counties may – and usually does – face two different taxing systems and, conversely, two competing firms in different counties may be imposed upon in differing measure by taxation procedures. There is also an inequity in that there is a tendency for the ratio of true to assess values to be higher on low-value property, which certainly applies to forest lands. And, finally, there is the

[30] Some funds go to the local government for improvement of standing timber, known as Knutson-Vandenberg funds, based on 10 percent of the revenue from the sale.

obvious lack of tax payability on the part of the firm that does not have steady annual income as is often the case on small holdings in particular.

Many methods of modification of taxation procedures have been proposed and tried in order to giver the timber land owner a fairer treatment, but with the exception of the ***yield tax***, that is, a tax on the timber stand only when it is actually cut, none has solve the multiple problems described above. And event he yield tax in a timber-based county violates the need for dependable source of income to the government.

As an example on the North Coast, Humboldt County has made considerable progress sin reducing the inequities in the a\taxation process. Wise expenditures have led to continuing aerial and field surveys, up-to-date mapping, and efficiently organized and easily accessible records on all timber lands in the entire county. Those responsible have also made considerable effort to inform the industry and the public about their operations. Essentially, the land and timber are assessed separately, with a small per acre rate for the land, dependent upon whether it is Redwood or Douglas-fir land, and then a per thousand board foot rate for the standing timber. Upon harvesting, the tax bill is reduced to that which represents just the small payment for the land. According to Section 12-3/4, Article XIII of the California State Constitution, cut-over land is exempt when 70 percent of the trees over 16 inches in diameter are cut, and second-growth timber is exempt from taxation until 40 years of age or, as amended, until maturity of the timber is ascertained by a special board. With the recommendation that declaration of maturity be applied conservatively to recognize the difficulties and high risks involve din growing timber, it is clear that the timber owner may easily preclude paying taxes merely by cutting the stand immediately before it is declared mature. If this practice were to be widespread in the Region, the government would have little income with which to carry out its responsibilities and a major depression would occur.

The timber industry claims that this is precisely what will happen if substantial amounts of land are locked up in a National Park! As a matter of fact, and from a regional standpoint, the economy may indeed be better off if there were a large park or preserve. The reasons for this are (1) with the present tax law the market for second-growth will undoubtedly be flooded as the young stands approach “maturity”; (2) such a park would removes some of this excess from the market; (3) creation of a park as proposed at least provides for payments form the federal to the county governments over a period of years in lieu of taxes, and (4) the inclusion of another industry, however small, would aid in reducing the percentage of the tax monies contributed by private timber industries to the local government. This just might be met by the expected demand for pulpwood as the new pulp mills proposed by the three principal companies[31] in the Region put them on line.

From the standpoint of the individual firms and individual taxpayers’ jobs, however, the picture is quite different. Creation of the park as proposed by the National Park Service would indeed virtually eliminate the holdings of one of these large companies, some 200 jobs, and the tax base of one of the local school districts. The public at large is going to have to decide whether it wishes to incur the cost of additional taxes and welfare while deriving the expected benefits of such a park.

Generally the effects of the present tax structure are (1) to cut the old-growth timber as soon as possible; (2) to sell or convert current land holdings to smaller parcels; (3) to re-vegetate with Douglas-fir since the tax rate is lower, and (4) to harvest the second-growth before it is declared mature. None of these are “Good for Conservation,” much less for preservation of the Redwood. And the last of the effects is in conflict with the silvicultural requirements of Redwood in particu-

[31] Arcata Redwood, Pacific Lumber, and Simpson (as I recall). [PEB, March 2005]

lar in that sound management principles concerning establishment and recovery of optimum growth rates dictate at least 70 to 80 years before harvest. On the other hand, with increasing use of small tress for remanufacture into particle board and pulp, this may not conflict greatly. The value of the Redwoods for such products, however, particularly if it has not had a chance to develop the prized heartwood, should be carefully assessed.

It is clear from the foregoing that the economic picture is not an easy task for John Q. Public to take in, digest, and then be ready to assist in the decision-making.[32]

OTHER ECONOMIC SECTORS

Three other industries are important in the Region: recreation, agriculture, and commercial fisheries. The latter, naturally involves no land use other than those that may have a detrimental effect on instream. offshore, and Humboldt Bay fishing grounds. A medium-sized flee is located at Eureka and another at Crescent City, along with canneries and fish processing plants. Salmon, Tuna, and Oysters are the principal species sought, the first and last being particularly susceptible to deposition of sediment and logging debris in the spawning streams, the Bay, and along the coast.

Recreation

The wide variety of climate and topography offers the recreationist considerable latitude in the choice of outdoor pursuits. Fishing and hunting form a major portion of the wildland recreation activities, as do hiking, picnicking, swimming, and camping. The resources vary from a cool, quiet Redwood grove to the rugged slopes of the Bureau of Land Management's King Range Preserve. As with the timber industry, there is a wide variety of supporting businesses, including motels and restaurants, gas stations, sports equipment retail stores, and so forth. The State Parks' facilities are usually used to capacity from about June 15th to Labor day, although some get considerably more use than others, and there has been some discussion concerning what constitutes "capacity."

There is very little private development of recreational facilities although those of the State are augmented where privately-owned lands adjacent to the Parks are withheld from timber harvest. In fact, there are virtually no roadside facilities along US 101 between Arcata and Crescent City, although several State Parks are accessible to or straddle the highway, and at least one lumber company has put a roadside table just north of Prairie Creek Redwoods State Park in Del Norte County. Most of the year such a lack of development us justified, yet on days when the weather encourages out-of-doors activities, it is almost impossible to find a place along the several hundred miles of beach that is not being used and is relatively accessible.

The bone of contention has appeared to be concerned with a lack of sufficient recreation facilities as well as a lack of sufficient preserved and protected stands of Redwoods. Actually, there is room for considerably more facilities in the existing State Parks, but at the potential expense of inadequately protecting the Redwoods themselves.

Further, the majority of recreationists desire to have their facilities very accessible, preferably within a short distance of where they can park their car. Catering to such a demand is not possible in the Redwood groves themselves, nor is it desirable from the standpoint of enjoyment of the stands or the preservation of the trees. Many tourists are satisfied with placing a decal of a Redwood on their car window thus establishing that they have in the Redwood country. This may ap-

[32] Comment added [PEB, March 2005]

pear overly cynical, but it is not: experience and surveys show that the majority of people using public recreation areas stay with short distances of access corridors, spend a short time in the area, and view most of it through the windshield. Why, then, all the noise about the Redwoods and other unique recreation attractions? Clearly the typical tourist doesn't particularly care – he or she gets the decal and is on the road again. But the few who want and really work to obtain a recreational experience somewhat closer to the resource are more vociferous. We hear from them more – and hear more from them – without having heard from this minority over the past century, there would be a dam in Echo Park, a subdivision in Yosemite, a stream-electric plant in Yellowstone, and a strip mine in the Great Smoky Mountains.

Many figures can be and have been cited to show how recreational use is growing as a result of increased leisure time, greater travel opportunities, greater disposable personal income, and longer vacations. It wills suffice here to give some index to this industry on the North Coast by pointing out that between 1953 and 1964 annual visits to the Redwood State Parks increased from one million to one-and-a-half million individuals. Using a reasonable[33] expenditure of $10 per person per day, recreation presently contributes greatly to the economy of the North Coast. These and other figures are cited as justification for expanding the park system, for creating a National Park; just as figures representing the timber economy are displayed in order to prevent its creation. In fact, either can be examined in a vacuum, nor can the scientific and national value of the trees be ignored. Not only are the Redwoods of scientific interest inherently, but the ecology of the Region is of value because of its windward location in the United States without upwind and upstream pollution sources and other human disturbances.

It would appear that much of the foregoing discussion has nothing to do with recreation, but the confusion is inherent in the National Park philosophy that seeks to preserve and maintain areas of unique scenic beauty and, at the same time, render them immune from the changes that inevitably accompany their use. The 1916 act that created the National Park Service stated that the purpose of the parks was

> To conserve the scenery and the natural and historic objects and wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

Yesterday's future generation is today's user who cannot help but impair the unique resource so that it cannot be so enjoyed by tomorrow's future generations.

Agriculture

Humboldt County, the first in California to have a farm advisor, was an agricultural prize, even thought is productivity was eventually surpassed by applying (some of it's) water to the arid Central Valley. Much of the entire Eel River delta was originally covered with forest, but it was cleared early for agricultural production to support the local mining and lumber communities, and for export. Dairy and other products were shipped to San Francisco markets, and even to the Orient, for many years in the late 1880s and early 1900s.

The most important facets of agriculture in the Region at present are dairying, primarily along the delta of the Eel and on some of the lower slopes of upland valleys, and range livestock, including sheep and cattle along the coast near Cape Mendocino and on the higher elevation prairie areas. Many lands that were converted from timber to range use have only been so maintained at considerable cost: land that grows good timber species does not necessarily grow good grass and, on the North Coast, this is especially so. Many successful ranches do exist, however, where suffi-

[33] For 1966!

cient land has been acquired to sustain an independent operation, and white-face Herefords and Texas Longhorns have been brought into the aria and crossbred to produce an animal capable of thriving on the high rangelands. Little change is seen for future agricultural enterprises, but the latter do come into direct contact with land management problems, particularly in the flood plain of the Eel River.

SUMMARY

Historical development of the North Coast area commenced with mining and a supporting timber industry. After the former waned the timber industry took over and has maintained its position as primary industry of the area. In addition, with increasing access, recreation has become a major part of the area's economy, and agriculture and commercial fishing have maintained a low but important portion of the business enterprises.

As is to be expected in our society, those areas that will field the greatest returns per unit cost of development have been exploited or developed first. The best sites for mines, timber harvest, grazing, agriculture, routes of access, and recreation offer the greatest benefits, so access is developed first to profit from those resources. Only subsequently are the less productive sites utilized. When the timber industries saw the wisdom of replanting or at least providing for the natural regeneration of forest stands – interest again was directed at the best sites – those that would produce the greatest amount of timber in the shortest period of time. It is ironic that the very tax laws, supported by the timber industry interests – and formulate in order to promote conservation of timber land resources now work in opposition to that goal.

The land is largely privately owned, particularly the high-timber-producing sites, and supports a major part of the State's forest products harvest each year. Yet the very accessibility that is necessary to get those products to market also makes the area accessible to the tourist and recreationist, many of whom now have an opportunity to visit the unique Redwood groves, and are doing so in increasing numbers.

These problems are commonplace: they are not unique to the North Coast of California except insofar as the particularly vegetative species is concerned. The Region should not take pride in the nature and magnitude of its conflicts any more than it should refuse to learn from its own history and from that of other regions that have doggedly fought their way through similar crises. If this is true, then there must be more basic problems than those that have already been discussed.

CHAPTER 4
THE BASIC ISSUES

USING THE TIMBER

It is high time that those who view with distaste a recently-cut slope recognized that this is an important phase of sound forest management. Where the species under management requires a great deal of light and room to regenerate, this is a biological consideration. In the case of the Coast Redwood, which reproduce better by sprouts than by seed – and little is known about planting the species – clear-cutting is biologically and economically justified, although individual tree selection is also scientifically sound. Removal of trees under the selection system of harvesting is undesirable in the Redwoods because of high cost as well as silvicultural considerations. To log by selecting individual trees would considerably raise the price at which the lumber sells to ensure that the private land operator can recover operation and production costs. Further, such logging techniques usually only pay where the individual tree has an unusually high value, and such is not the case with Redwoods, particularly second-growth stands, which will soon make up the bulk of the Region's Redwood timber harvest. In addition, damage to residual trees is more likely and access routes are used frequently rather than being closed upon completion of a harvest operation. Basically, logging Redwoods in a manner other than clear-cutting blocks of timber is uneconomical, but even more basic is the fact that the public at large doesn't appreciate this and the loggers, foresters, and timber companies have done little to alleviate the situation. More than anything, it is a problem of attitudes[34].

We recognize that many shady land deals in the past have led to the large holdings that exist today, but to hold this against the lumber industry that is trying to utilize a vital natural resource is closing our eyes and minds to the important role wood and forest products play in our economy.

Growing wood provides not only an important material of commerce, but also shelters wildlife and aids in buffering[35] the movement of water through the hydrological cycle. Growing wood for commerce involves lots of space and time, and many risks. As such it is a marginal operation on many sites and highly profitable on relative few. Where it is not economical, the land is ignored, or abandoned, or used for some other purpose following removal of the forest cover. Utilizing the productive capacity of the soil means harvesting the growing crop and replacing it with a new one in as short a time as possible so that the land will not remain unproductive, which is bad from an economic and environmental standpoints. Doing this upsets the balance of nature that has been so long in developing on that area, and the ecology changes. Thus, the number of life forms – and the numbers of each species represented – may increase dramatically at the same time that the soil is exposed to erosive forces such as wind and water. Thus, the timber industry is challenged by its stockholders to keep paying dividends and to invest in the future and, at the same time, pacify the remainder of the public that wants to see the land covered with a green mantel right away and to see the beautiful brown-eyed deer protected even though they are eating up all the seedlings.

---

[34] The national battle over clear-cutting in National Forests erupted in the early 1970s as the environmental movement swung into high gear. It remains a sensitive issue for many. {PEB, March 2005]

[35] My current interest in sustainability and how our natural resources are distributed points, in particular, to biodiversity as a critical environmental buffer for humans. [PEB, March 2005]

But it isn't all one-sided: those concerned with the management of natural resources all too often forget that the public is the consumer, not only of the forest products, but of the other land values too: the water, wildlife, and scenery. Our laws define land as real property: we do not own the land, only the title to it, which means we can use it. We are in effect stewards of the land during our tenure of ownership, and the excellence of that stewardship should aim at contributing to our present economy and, at the same time, ensuring a resource base for future generations. Such a job is considerably easier when dealing with a renewable resource such as timber in contrast with non-renewable resources such as minerals or oil. Not only has the timber land owner achieved the opportunity of making a living and a profit and contributing to the society, but he/she also has a responsibility to inform the questioning public honestly, regardless of wild accusations based on distorted and misinterpreted facts.[36] Such a lovely state of affairs has been conspicuous by its absence in recent years on the North Coast.

Even with the timber industry adequately informing the public about specific land management practices, and the setting aside of sufficient stands of timber to satisfy the preservationists, the two uses of land must somewhere be side by side, the ugly with the beautiful. This is something that we all have to accept, although through intelligent planning the side-by-side confrontations can be minimized by effectively using topography and planning routes of access. After all, it is the soil that supports both the preserved stands and the productive timber growth. That's not quite as trite as it at first sounds. We do, in this country have the blessing (at least at the present time) of plenty of room: we can afford to preserve or not use for economic gains that, were we living in Europe, would have been placed under intensive management long ago. On the other hand, we cannot arbitrarily lock up resources in the face of poverty and low living standards. We can balance our needs and desires, and it is the degree of that balance that is the basic issue.

When lands capable of production are locked up or withdrawn from their most productive use the public must be willing to pay the price, usually in the form of taxes that may increase on other lands. But in the Redwood Region removing a large portion of the timber-producing lands will shift the tax burden of those lands not to the public generally, but to other timber companies in particular and, as pointed out, with sever consequences to school and other local service districts. This argument is displayed by the timber industry as something that is undesirable in the "park or payrolls" campaign now being conducted on the North Coast. But the public mad indeed decide that it wishes to pay the price, to pay more for lumber, to reimburse the district, to shoulder higher taxes to support in lieu payments. Even if the public wished to so act, and the timber industry were agreeable, misunderstanding precludes communication, a third basic problem.

The very campaign that the industry is waging – "parks or payrolls" – contributes greatly to that misunderstanding: it is rather a question of "parks *and* payrolls, and how may we achieve both?" both sides of the park controversy have been guilty of throwing up walls to communication, but it is not the intent here to find fault or place blame for the situation. Rather find a way out: thus, we can start by recognizing that attitudes, responsibilities, realities, and communications are important, have been neglected, and must be improved.

[36] Currently, I do not use the term "land owner" preferring, instead, to use the more generic "land manager" or "land operator": those terms more accurately convey the thought that we are stewards (see Stewart Udall's *The Quiet Crisis*) of the resources of the planet. From a more environmentally friendly viewpoint we only have the *use* of the land (and water), reflected in the fact that both are *real*, not *personal* property. And the public has the right to know how Earth's real property is being used, conserved, to assure sustainability for our descendants. See also footnote 35, page 37. [PEB, March 2005]

Developing the Water

Basically, on the North Coast, there is too much water. In the one case there is a surplus that is desired in the southern part of the State, and in the other case, there is a severe problem with floods. The State as a whole is willing to pay for water development projects at present on the upper Eel River watershed for export of surplus waters to the Central Valley and even the Los Angeles area, but it is no apprised of the flood problem and probably unwilling to help pay for its rectification.

The preliminary surveying, reconnaissance, formulation, justification, and the construction of such projects is a complex problem for engineers, hydrologists, and economists.[37] The law plays an important role, too since the people living on the lands from where water is to be diverted are protected under the State County of Origins Act. Unfortunately, the land manager is often either not consulted in project formulation or is uninterested with the unhappy result that water projects often to not fir in with developing land patterns and conflict with goals of private and public managers alike. Again, highways are important, for a water resource project may require new or better access routes that have an impact on the land through which they pass and on the land that is thereby made accessible.

It often takes several years between the time when the need for a water project is first recognized and the time its construction is completed.[38] By the time a project has been found to economically unfeasible, if that is the case, enough money have been spent so that the decision to abandon it is a difficult one. Enough flexibility is always present, however, to allow the formulating or sponsoring agency to add, delete, or otherwise change the original proposal and thus make the project worth while. Usually, however, this is not the case, and development takes place according to accepted standards of justification, construction, and operation procedure.

All federal agencies must comply with the practices agreed upon by the Federal Inter-Agency River Basin Committee in the "Green Book," and the State follows the same or similar practices. These stipulations are concerned with reimbursement periods, interest rates, methods of data handling, and application of benefit-cost analysis and the computation of the benefit-cost ratio. The latter must be favorable for each separable segment of the project. Such practices ensure that benefits realized from the project do exceed costs (provided that conditions do not change between the time of project authorization and completion), but the analysis does not always guarantee that that condition will be maximized, the goal of private enterprise. Full assessment of all the possible locations for dams, alternate purposes and sizes of dams and appurtenances, and operation procedure would be an almost impossible task for any given project. Fortunately, the experienced engineer and/or planner may instinctively select one or several possibilities that may be later limited either by economic analysis or other external constraints. By and large, the public's interest in the investment of their tax monies in water resource projects is protected, but continued scrutiny is required. In flood control, particularly on the North Coast, this is vitally important.

Floods are a normal part of the natural scene. They occur with some degree of certainty, and yet their predictability is, at present, elusive. We know how to account – evaluate – for this unpredictability in flood control project economics, and we know what causes floods, as well as the time of the year during which they are most likely to occur. But, up until a few days before a flood, and up until a few hours before the peak, we cannot accurately predict when the flood will

[37] Not to mention politicians! [PEB, March 2005]

[38] Note that the National Environmental Policy Act that requires Environmental Impact Statements was still four years off in 1966. [PEB, March 2005]

come or how much water will be involved, respectively.[39] Our principal deficiency in this capacity lies in uncertainty about the weather.

Under natural conditions, a stream may be expected to reach flood stage, that is, bank full capacity once a year on the average, and to exceed that rate of discharge once every two to three years, more specifically, every 2.33 years on most streams in the temperate zone. This is what we think of when we say that a stream or river is flooding. To the hydrologist, however, all peaks, whether they be above or below flood stage are of interest because they represent a nearly random distribution of occurrences. As such, flood peaks may be expressed in terms of probability based on their magnitude and frequency of occurrence. This allows one to identify the "annual flood," the "one-hundred year flood," or the "one thousand year flood."

Figure 17 Eel River delta near Ferndale at flood stage (bank full capacity) on the evening of December 20th, 1964 and the following morning when the 3,000 mi^2 watershed's record flood crested at 950,000 cubic feet per second. Arrows point to the same vegetation for reference.

The chance of experiencing a one hundred year flood in any given years is one in one hundred if the magnitude-frequency relationship is based on an analysis of the annual peaks. Each year is considered as an independent event so that, with the exception of the little-understood wet and dry climatic cycles, the same probability of occurrence exists in every year. This does not preclude having a one hundred year flood equaled or exceeded more than once in a year, or having a one hundred year flood this year and a one thousand year flood the next. Nor does it imply that there will be one hundred years between hundred-year storms (or floods), except in the long run. Actually, about all that can be definitely predicted is that as we keep more and more years of record, we can expect to experience larger and larger floods, simply because the larger sample

[39] Since that sentence was written, any aware citizen will know that times have indeed changed! Computers and sophisticated software provides ample prediction for flood peaks at specific locations on a stream or river as well as for local flooding conditions. [PEB, March 2005]

(more years of data) provides a better opportunity to observe infrequent phenomena. The same is true, of course, of the other end of the discharge spectrum droughts.

As frequently pointed out, the annual cost of flood control has been increasing, but the losses from floods have not been decreasing. This is due to (1) assumed protection and consequent greater flood plain utilization and development that puts higher values at risk; (2) more and higher floods as more time is involved and there is more encroachment on the flood plains, and (3) to a serious lack of flood plain zoning. Zoning does not necessarily mean excluding development: certain types of land use benefit from flood-deposited, and others can legitimately withstand periodic inundation. Secretary of the Interior Stewart Udall affirms the constructive approach to zoning:

> But local governments still hold the key to planning. Many zoning boards are as important as the courts. Zoning regulation should not merely prevent the worst from happening …, it should encourage positive action.

Ironically, if there were no flood plain development, there would be no justification for flood control but some reasonable restrictions are necessary.

As discussed in Chapter 2, there are certain factors that we know have an effect on the occurrence of floods, but we must also recognize that humans have an influence as well. Although the graph (Figure 18) shows a high degree of correlation between one our major activities on the North Coast and floods on the Eel River, we cannot with certainty claim a direct cause and effect.

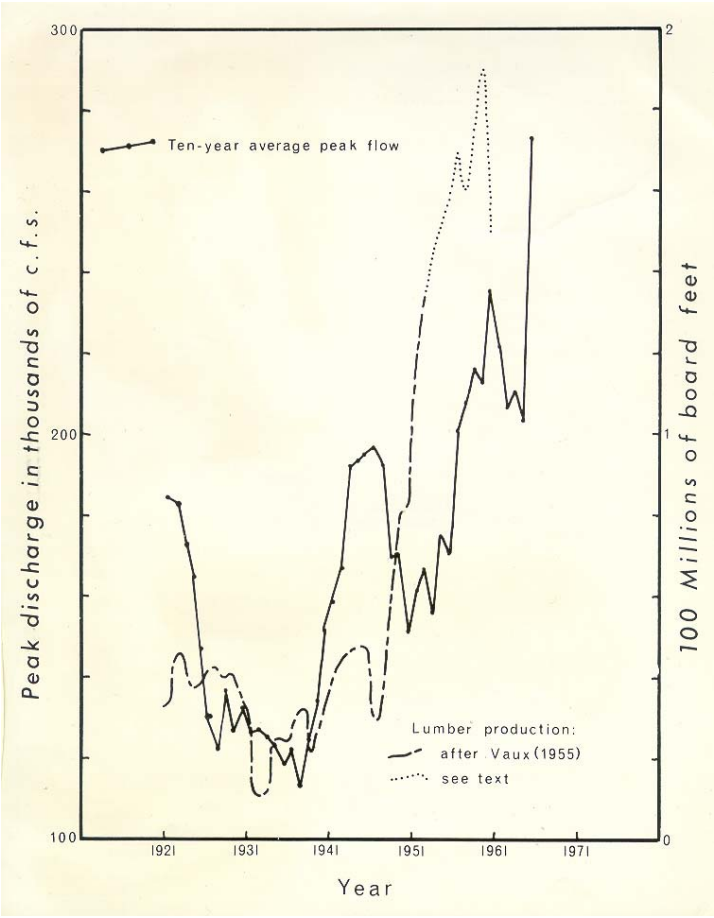


Figure 18 Data for 1953-1960 for Humboldt County lumber production were estimated from Zivnuska *et al* (1963) and for 1921-1952 from Vaux (1955) while data for 1947-1952 were present in both reports. During this time, the County production was nearly a constant 50 percent of the North Coastal region and that percentage was applied to the latter area's data fro 1953-1960.

It is likely that roads, in particular, have played an important role in this relationship, as well as the proximity of the various logged areas to live streams, consequently affecting the degree to which each logged area contributes to the flood peak. If logging activity is an index to the well-being of this timber-based economy, then we can expect that other land uses, notably grazing, have intensified similarly. What is important to recognize is that as the years pass we may naturally expect larger flood peaks: thus human activities should be concerned with minimizing disturbance to those factors that influence flood flows. On the other hand, logging does cause damage to the flood-retarding capability of the landscape and, of course,

to sediment production as well as the local ecology. Dr. James R. Wallis (1963), who has studied sediment problems in detail on the North Coast, states in his dissertation that:

> It is apparent that northern California's mountains are eroding at a prodigious rate, and that this rate is greatly in excess of the rate of new soil formation. It is also apparent that man's current land use practices are producing the bulk of this excessive erosion. Foremost of these activities is logging operations with roads and landings located in the draws and bottoms of declivities, and the conversion of comparatively non-eroding brush and forest cover types to eroding grasslands.

The increased flood peaks and sediment loads go hand in hand, and we thus should be prepared to deal effectively with the increased peaks and sediment loads that we can reasonably expect to occur. But we cannot condemn the lumber industry for such a state of affairs even if we could prove beyond the shadow of a doubt that logging has caused the flood peaks to increase: without the timber industry there would be no economy to suffer losses that occur naturally, and the industry's influence in the economy has precluded institution of effective restraints on practices until the recent enactment of the State Forest Practices Act. We do, of course, know how to log and locate and build roads without producing excessive runoff and sediment, and if there practices are not followed, then condemnation would be in order. We simply have to face up to the fact that if we wish to develop the area for productive enterprises, then we had better be prepared to accommodate a changing situation.[40]

Given that floods are a natural part of the stream's hydrology, we can hardly go about protecting lands from flooding by building levees and expecting there structures to control the floods. The hydrology of streams is dynamic, and floods are an integral part of that hydrology. When a flood flow is produced on a watershed and spreads out over a flood plain, it deposits silt, which makes the land richer in nutrients for future crops, although it may destroy existing crops. The flood peak thus spread out fills a certain cross-section and flows at a specific velocity dependant upon the slope and roughness of the channel. If the width of the cross-section is restricted by levees, for example, the depth must be increased. Only a slight increase in velocity accompanies this increased depth of water and consequently the height of the water above the flood plain is greater than without the levees. Under such conditions a break in the levee or overtopping and erosion of levees can result in more devastating conditions than would have existed without the levees because the flood plain lands are inundated suddenly and often without warning. As I have pointed out on various occasions, flood-producing rains are often accompanied by higher-than-normal storm tides. Thus the lower ends of the levees proposed by the Corps of Engineers were insufficient in height to preclude ocean water from also intruding on the flood plain. This was borne out in the 1964 floods when, had the levees been built, the sea would have overtopped them by three feet.

Figure 19 Eel River bridge north (downstream) of Scotia following the 1964 flood.

Highways, often located adjacent to

[40] It turns out – and I published this information on a causative effect in 1966 – that since evapotranspiration decreases as timber is harvested, there is a greater amount of soil moisture left in the cut-over stands and this contributes to earlier and greater flood peaks in the subsequent year. [PEB, March 2005]

streams, also contribute to flood problems as well as potentially aiding in their control. A classical example of the former is the south approach to the Richard Fleisher bridge that carries US 101 over the Eel River. It appears that the increased depth of water may have played a role in the loss of the bridge during the 1964 flood: the elevation of this approach is actually higher than the town of Pepperwood, which was located only four miles upstream and is now wiped out. How much of a role the highway approach to the bridge played in increasing the damage in Pepperwood should be thoroughly investigated. Another example is shown in Figure 19 where one span of the US 101 bridge over the Eel was destroyed as water and logging debris dammed provided the destruction.

Once excess water is in the stream channel, it is difficult to control: the best place to practice flood control is where the water hits the land surface, or as close to it as possible. This is economically sound as well as ecologically sound, for it is here that management of the vegetative cover can be accomplished with the dual goals of harvesting crops and controlling runoff.

Finally, diversion of Eel River water and consequent reduction of downstream flows could have an effect that has been observed elsewhere: salt water intrusion. Regulation and reduction of Sacramento River flows has created a major headache for San Francisco Bay, and the same fate could be worse than the periodic flooding in the delta of the Eel.

Planning for Recreation

The recreational use of our wildland resources is recognized to make use of a wide variety of resource settings and to satisfy a wide range of needs and desires for outdoor experiences.

There is, in fact, a spectrum of outdoor recreation areas. At one end of the scale is the highly developed area that has undergone extensive manipulation and bears little resemblance to the original landscape. Such an area is *user-oriented*, that is, it is located, planned, developed, and operated to satisfy the needs of the users. At the other end of the spectrum is the *resource-oriented* area, located because of its intrinsic natural beauty or value as a unique feature[41]. Such areas show little development and the prime concern is for the resource, not the user. The principal purpose of the user-oriented area is to accommodate large numbers of people for short periods of time, in contrast to the resource-oriented area where the principal purpose is to enable the people to enjoy the natural scene. Intermediate between these extremes, one finds great variation in degree of development, of purpose for establishment, and within some larger recreation areas several sub-areas may be identified.

As one travels out from the urban centers, there is a tendency to leave behind the user-oriented recreation area and move toward the other end of the spectrum. As this is done, the intensity of use falls off, the size of the area becomes larger, the length of the visit increases, the availability of management funds declines; the ability of the area to realize revenues also declines and, of course, the resource becomes more important than the user.

Resource-oriented recreation areas are noteworthy in this inherent lack of ability to produce an excess of benefits over costs. Consequently wildland recreation on such areas is subsidized by the government. The federal government, in particular, can afford to underwrite such a monetary loss when it is deemed to be in the long-term public interest or, more specifically, when the values involved transcend measurement in standard economic terms of dollars and cents; but a local government often cannot afford such luxuries unless local property values and businesses provide tax revenues that would be non-existent without the presence of those areas. Private enterprise can justify such a loss only it determines that the public relations gained are worth the investment in protection and recreation development, a rather understandably rare situation. Private firms, how-

[41] These two terms, and the characteristics of the two polar types of recreation areas, are described in Clawson (1963)..

ever, can often make wildland recreation a profitable operation if there is some unique "come-on." Under the new charges for recreation use of federal lands under the Land and Water Conservation Fund Act, this situation may soon change so that private landowners will not have to compete with the typical nearly free rates of use of public facilities run by the government. In addition, competition with other uses of the land tend to diminish as the traveler moves out from the urban center, and the wildland manager becomes more involved. This distribution of types of recreation areas around a municipality may be thought of as a series of probably ill-defined zones that may overlap. The greater the intensity of the urban centers, the less the likelihood of having sufficient room to permit protection of resource-oriented recreation areas.

Much of the north Coast lands, however, are sufficiently far from urban centers to both qualify as resource-oriented recreation areas and not to exhibit – or suffer from – poorly-defined zones of types of use. Certainly user-oriented areas are found and around the relatively small cities and towns of the Region. But the lands that may serve the needs of resource-oriented recreation areas are also in demand for timber production, and it is only in the high country some distance from the coast that we find the Wilderness Areas under the jurisdiction of the U. S. Forester Service. These represent the ultimate in resource-oriented sites. Such lands are not only more valuable from the standpoint of recreation, but they are also less valuable for timber production due to their low productivity and relative inaccessibility. Establishing them as wilderness areas serves to keep them that way, and recognizes their recreation potential as well.

Here again, highways appear as important tools in land management. Serving as the principal means of access to lands for a majority of recreationists, they do in fact determine the patters of land use as well as result from improvement of earlier routs of access. Although it mean cutting many trees, the US 101 freeway that parallels the Avenue of the Giants north of Dyerville is undoubtedly the most serene stretch of modern roads in the Nation. As an overall plan, it was excellent, for it preserved the old highway and provided more intimate access and more leisurely travel for those who desire to leave the high-speed freeway and provided more intimate access and more leisurely travel for those who desire it, yet it satisfies those who need only to see the trees through their windshields. That, incidentally, keeps the traffic through the groves down, too, undoubtedly contributing to their longevity.

A clear majority of outdoor recreation areas are located in close proximity or immediately adjacent to water. And many of our outdoor recreation activities would be either non-existent or very unpleasant without it. Fishing, swimming, camping, boating, water-skiing, and much of sight-seeing requires water. And many of our other activities are enhanced by the presence of water. The nature of the use of the water resource in recreation areas is such that some degree of development is usually required, and it may thus be said that water-oriented recreation areas fall intermediately between the user- and the resource-oriented areas. In part, lake short frontage may be intensively developed with boat ramps, swimming access, ski jumps, etc. But parts of them are also maintained in their undeveloped condition and, of course, the area is developed at the site of the resource. In part, too, water resources are demanded in their natural form, particularly for white-water canoeing, fishing, and scenic value. Preserving a stream in its natural condition is a rather difficult task, to say the least. If we recognize that the stream and the watershed are part of an integral whole, then it is folly to lock up a stream as a "wild river," for example, yet let unrestricted development of the watershed that could alter stream flow continue. Just excluding dams from a stream does not make it a wild river.

SUMMARY

The attitudes of timber resource users and of the public are a basic source of the conflicts that occurred on the North Coast, and lack of communication between responsible groups and individuals has been a contributor along with the irresponsible acts on both sides to misunderstanding and mistrust.

The timber land owner deserves more credit that he/she receives for the important role played in both the local and national economy; and the preservationist groups likewise deserves more credit than they get for the difficult, often unpopular job it has attempted to do for the benefit of future generations.

Development of the water resources of the North Coast is at once an economic and engineering problem, but the land manager must play a role as well. There is just too much water on the North Coast to being with, and there is a local need for flood control and a regional need for export of water to the arid southern portion of the State.[42] The nature of floods is such that we can expect flood peaks naturally to be higher in the future and, with extended human activities we can expect the situation to get even worse. Highways play an important role in aiding – or exacerbating – the control of floods, and have considerable impact on and reflect land use patterns.

Finally, the basic nature of the use of wildlands for recreational purposes conflicts with most desirous goals of the timber industry. In a Region with so much water, the recognition that much of our wildland recreation is associated with water, and the present condition of the timber economy, the challenges and the opportunities are abundantly clear.

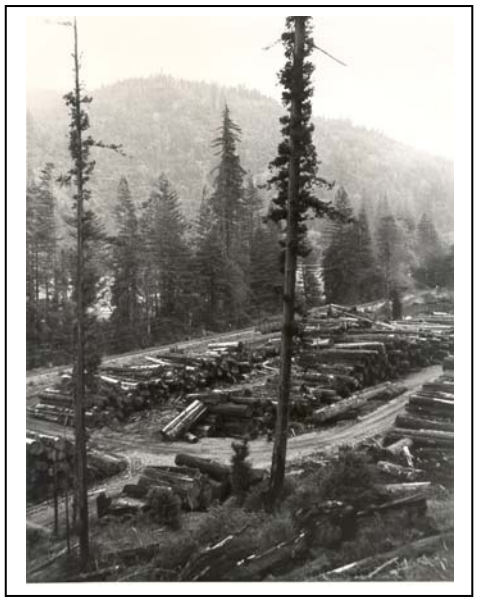


Figure 20 Log deck near Dyerville; Eel River beyond

Figure 21 Debris from cutover land, log decks, and business sites following recession 1964 flood in Eel River delta. The trees in left center are the same as those in Figure 17 (page 40).

[42] My current state of mind dictates that that is not a particularly realistic attitude. That is especially true as one considers the issue of sustainability and wonders whether many of the Nation's sunbelt areas – including Los Angeles, San Diego, and vicinity – are sustainable in a variety of ways, all of them in consideration of resources: air, biodiversity, soil, water, energy, and space. That wasn't a particularly troublesome issue for the 1960s. It is now. [PEB, March 2005]

CHAPTER 5
THE PROBLEMS CAN BE SOLVED

THE CHALLENGE

The challenge on the North Coast of California is to practice conservation of its unique and plentiful natural resources. More specifically, to both use and preserve – in proper, that is, acceptable balance – the unique Coast Redwoods; to manage the water resource effectively and economically; and to develop the recreational resource with a sensible plan that will bolster the economy.

For the timber, this means ensuring recovery of the capital investment that have been made in the industry; using research information on regeneration to ensure a continuous harvest and protection of both the forest and other associated resources, and planning for the future of the industry in terms of changing markets and characteristics of the supply of raw materials.

For the water, it means recognition of the interrelationship between activities of man on the land and stream hydrology; the demands of the Region's water resources within and outside the Region; the responsibilities of different agencies in development these supplies, and an integrated plan of development so as to reduce losses from floods and to bolster water supplies on the North Coast and elsewhere in the State.

For the recreational resources, an effective plan must avoid economic damage to the primary industry; aid in the preservation of the Coast Redwoods; take cognizance of the nature of the demand; capitalize on the unique vegetation and natural opportunities available, and meet the increasing need for outdoor recreation experiences.

WHAT CANNOT BE DONE

The most important action to avoid is a lack of action. Lack of concern about the future development of the Redwood Region will lead to haphazard growth, inefficient investment, and dictation of plans for resource development by individuals and groups outside the Region to those inside who should know best how to integrate the management of the land.

The timber industry cannot make a pretense that it wishes to re-live or to continue to live in an old-growth economy. Nor can it ignore new markets, diversified products, and a changing raw material. And it cannot overlook the fact that it has responsibilities to the public as stewards of the land in that it must extend its concern from just the land's productivity of timber to the role of the land in providing recreational opportunities and in regulating the disposition of rainfall.

All interested groups cannot afford to listen only to those who hold the same views. All of those interested have a responsibility to inform those who see the conflicts from another standpoint honestly, and to see their viewpoint as well. The other side must have legitimate motives, otherwise there would hardly be a basis for conflict. In the words of Regional Forester Charles A. Connaughton (1963):

> The professional, trained and knowledgeable in terms of technical adequacy, needs the influence of the public to be sure that the resource use and attitudes are in tune with general opinion. If they aren't, no matter how technically sound the decision, it is doomed to failure. On the other hand, public attitudes which do not take the professional recommendation into full consideration are liable to be unattainable and doomed to frustration.

The tall trees located on Redwood Creek cannot be preserved by inclusion in a National Park. The whims of nature assure no guarantee that these particular specimens will be the world's tallest trees a century from now, or tomorrow, for that matter. To the tourist, whether a tree is 350 or 360 feet tall is of little consequence anyway, and including them in the proposal for Prairie Creek Redwoods State Park by extending a corridor to include them is poor planning and degrading to the excellent planning of our other great National Parks.[43]

The role of accessibility cannot be ignored, for the location of freeways and lesser roads both constrains and enables the land use of the future as well as reflecting the land use of the past. Nor can the fat that highways play a role in the migration of wildlife and in the hydrological cycle be overlooked: hindsight gives us to vivid a picture of incongruities in the landscape, sediment production, and altered hydrology.

Nor can we ignore the basic ecology of the Redwood Region: to so would be to ignore the forces that shaped it, and to upset the balance would be release those forces for its destruction.

We cannot use the fact that logging, in particular, and other land uses in general, had an effect on the magnitude of and the damage done by the 1964 floods as argument for a National Park: there are plenty of other valid reasons.

In short, an attitude of "let George do it" – or laissez-faire – will be as disastrous to the Region as would the complete exclusion of an intelligent plan, or as would the complete exclusion of all the remaining old-growth Redwoods. Neither the timer nor the recreational sites, nor the number of floods are inexhaustible: nor are the time and opportunities. The time is not, and the opportunities are clear.

THE OPPORTUNITIES

Although many proposals for national, state, and private recreation development exist, one stands out. Conversion of Humboldt Redwoods State Park and some surrounding land to a National Park can solve many of the problems discussed, and is presented here as an example of the nature of the planning that must precede a major land use decision.

In the American Forestry Association's report on "Redwoods and Parks" by Samuel T. Dana and Kenneth B. Pomeroy, the authors state that:

> Humboldt [Redwoods State Park] seems to the authors ideally suited for the purpose. It contains the most outstanding groves in the Coast Redwood region, notably in Bull Creek Flat and Dyerville Flat. It offers marvelous views along the Avenue of the Giants and elsewhere. It has a substantial mileage of attractive river frontage. It has a better climate for creational purposes than the parks farther north. It presents a compact administrative unit of 38,318 acres under the State's Master Plan with little impairment of an economy that is currently in precarious balance. However, such an enlargement would have considerable impact upon landowners adjacent to Humboldt Redwoods State Park.[44]

---

[43] My view on this issue did not approve of having the world's tallest Redwood cut down by a reportedly inebriated logger not long after Park establishment, even though it did prove my point. [PEB, March 2005]

[44] At the time I cited this alternative and supported its selection, I had not visited the Jedediah Smith Redwoods State Park as I described in footnote 7. I was moved to tears with its serenity, beauty, seclusion, and extent. Further, I suspect that most of the recorded visits to the Park are people stopping along the major highways that bound it, not by those who, as I did, drive the ten miles of unimproved road with more stops than prudent fuel-saving would dictate. I don't think I have ever been so impressed with a recreational resource. And, in a way, it's probably just as well that it is not a National Park; its preservation would be more difficult, and I'm glad I had the opportunity of seeing it in all its glory. [PEB, March 2005]

But the area has more to offer than superb groves of Redwoods, better climate, and easier administration, although those are almost sufficient. From the standpoint of aiding the economy, the proximity of a National Park must be considered: one located north of Eureka will tend to exclude travel through and south of that city via US 101. National Park-visiting tourists will go from Lassen to Prairie Creek (if that were the Park) to Crater Lake, especially when US 299 is improved along its entire length between US 101 and Redding. The prime recreational area of the Region should be located *south* of Eureka it is to be planned with an eye to enhancing travel through the Region and contributing to the economy.

Enlarging the proposal even more than stated would enhance the Park by including a part of Mail Ridge and extending eastward along the main stem of the El River to a point near Fort Seward that would include a part of the future reservoir behind Sequoia Dam near Eel Rock.

The varied opportunities for outdoor activities are greater at Humboldt Redwoods State Park than elsewhere, with nature walks in the groves on the flats, hiking at the nearby higher elevations, swimming, camping and, upon the building of Sequoia Dam, water-oriented activities that will be unsurpassed in the Region. Indeed, it would be hard to surpass the great variety of recreational resources that would be available in such close proximity anywhere. The scenery is also varied, with views from Mail Ridge, the divide between the Eel and the South Fork of the Eel Rivers that extends from the high coastal range peaks to Fort Bragg and the Pacific Ocean.

Such a park would contribute to the local economy thorough private recreational developments and service and supply facilities planned for an established nearby. Adjacent lands are in fact marginal for timber and grazing in many instances (except downstream from the site) and their enhancement can only lead to greater land values and higher tax revenues to the County.

Further, if such a plan as is here discussed were adopted, it could mean inclusion of greater recreation benefits (as well as flood control, hopefully) in the dams proposed for the Eel, and thus possibly enhance their benefit-cost ratios and speed their construction, to the benefit of all.[45]

Humboldt Redwoods National Park would be a year-round park in contrast to the restricted season of use nearer the coast. It exhibits varied soils, vegetation, and climate, and has a longer summer season with accessibility during the winter months for scientific inquiry and excursions, as well as limited recreation potential. It could also be a unique park in that it could include some history of the logging industry as well as good and bad examples of land management, all visible from, included in, or adjacent to the park boundaries. For more intensive study, the Northern California Coast Range Preserve, privately owned by The Nature Conservancy on Elder Creek (a tributary to the South Fork) is near by. It, along with other lands on the watershed of the South Fork could be easily controlled by a series of small projects under Public Law 566 (83rd Congress), the Small Watershed Protection and Flood Prevention Act, to aid in control of floods along the eel. Any such development, according to the terms of the Act, would be locally initiated and controlled, with aid from the federal government. And, of course, with inclusion of flood control as a primary purpose on the main stem dams now proposed, floods would be controlled with and below the park. Again, the opportunity here to present to the National Park-visiting public a series of examples of good land management practices is an enticing one.

Camping facilities would be best located outside the groves, for the unpleasant micro-climate and the chance of upsetting it favor only limited development of trails and minimum comfort stations therein. Any periodic flooding and sediment depositions that does persist would benefit park

[45] To my knowledge of the lower Eel River dams have been built – or approved – as of this editing. One, Branscomb Dam, was planned primarily for recreation enhancement, including maintenance of downstream flows for salmon (a first back in 1963 or 1964), was not approved while I was still resident on the North Coast. [PEB, March 2005]

management by enabling management to shift trail locations with changing landscape and to practice rotation of use so as to not unduly disturb the trees.

The creation of a National Park as described would take considerable planning, foresight, and flexibility. And accomplishing it would not solve many other problems of the Region. But opportunities exist here, too. Outside the National Park recreation opportunities can be developed by local governments and private interests. The latter, in particular, can benefit from the tall trees on Redwood Creek that provide that necessary and unique "come-on" for a profitable recreation area.

The opportunity also exists to avoid the creation of a carnival atmosphere in developing the recreation potential of the Region through planning and self-imposed controls. It is far easier to prevent the use of garish billboards and undesirable advertising than it is to eliminate it. In fact, a cooperative regional recreational planning commission would be most desirable to both plan and control recreation.

There is a continuing opportunity to modify the State's tax load and, at the same time, prepare realistically for the future. For example, tax relief for firms that hold old-growth stands off the market such as Pacific Lumber Company[46] that has continued to pay $30,000 per year on 200 acres close to Humboldt Redwoods State Park for recreation purposes, although, in this case, it is almost exclusively for scenic purposes along the Avenue of the Giants. In effect, where a firm sees fit to withhold timber form harvest for recreational purposes, and adheres to local rules on advertising, for example, it might select the yield tax option, thus giving an incentive to private recreation management that does not now exist, but at the same time reserving taxability if the land reverts to timber production.

As two timber firms have already done by opening pulp mills, the industry has an opportunity to realize the potential of the renewable timber resource, to practice land management effectively and with responsibility.

The residents of the Region have the opportunity to recognize that the public as a whole has a legitimate interest in the affairs of the Region, and can benefit from their aid as well their good well, planning, and dollars.

In summary, the opportunities are to meet the challenges and resolve the conflicts that have erupted on California's North Coast. Whether Humboldt Redwoods National Park is a reality or not is immaterial: but it is exemplary, and illustrates how a conflict may be resolved with the realization of benefits not heretofore seen. But it is imperative that something be done: that forest conservation practices be improved in the woods as well as on paper; that floods be controlled and water be supplied to the Region and to Southern California; that a wide range of recreational opportunities be provided so as to diversify the economy of the Region still further and thus prevent economic recession from failure of one sector; and to take responsibility for the land that has given rise to both the area's history and its present and future potential. There is, indeed, little that cannot be accomplished with good common sense, widespread cooperation, and unobstructed communication.

[46] I note that in footnote 3 I identified the company that made this contribution was Arcata Redwood Company. One of the two pronouncements, of course, is incorrect and at this time and distance, I know not which. [PEB, March 2005]

REFERENCES AND OTHER SOURCES

American Forest Products Industries, 1958(?). *Facts About the Forests of the Redwood Region*. In cooperation with the California Redwood Association, 576 Sacramento Street, San Francisco, CA.

Anderson, H. W., and J. R. Wallis, 1965. "Some Interpretations of Sediment Sources and Causes, Pacific Slope Basins in Oregon and California." *Proceedings*, Federal Interagency Sedimentation Conference, 1963, USDA Miscellaneous Publication No. 970. pp. 22-30.

Anonymous, 1966. "Federal-State Agencies Unite on Eel River Development," *Western Water News* 18(9), September, p. 1. Irrigation Districts Association of California, 821 Market St., Room 945, San Francisco, CA.

Associated Press, 1963a. "40-Year-Old Law suit Over Colorado River Lost by California; Action Clears way for U. S. Arizona Projects" *Humboldt Times*, June 4th. [See many other article sin California, Arizona, and Colorado newspapers, the *Christian Science Monitor*, and the *Wall Street Journal*.]

Associated Press, 1963b. "$888 Million Expansion of Water Plan Urged: Speed up of Eel Dams." Humboldt Times, July 2nd.

Black, P. E., 1963. *Statement Concerning the Corps of Engineers' Proposal for Flood Control Levees on the Eel River*, California. Hearings at Ferndale, CA November 20th.

Black, P. E., 1964. *Report of Facts that do not Support the Corps of Engineers' Proposal for a Flood Control Project in the Delta of the Eel River, California*. Consultant's report filed in Office of the U. S. Army Corps of Engineers, Washington, DC.

Black, P. E., 1964. *Climate, Soils, and Hydrology of the Redwood Region*, Consultant Report to the National Park Service, Department of The Interior, Washington, DC.

Black, P. E., 1996. *Watershed Hydrology*, 2nd Ed., CRC Press/Lewis Publishers, Boca Raton, FL. 449 pp.

Black, P. E., and P. J. Zinke, 1964. "Hydrology of Old-Growth Redwoods." Paper presented at the Fourth Annual Western Meeting of the American Geophysical Union, Seattle, WA. December, 30th.

Black, P. E., 1965. Land Use and Floods. Statement before Joint Public Hearings of Department of Water Resources and California Water Commission on Bulleting No. 136 *North Coastal Area Investigation*, at Eureka, CA. February 10th.

Boe, K. N. 1964. *Silvicultural Research Plans for Redwood and Douglas-fir Forests in California*. Pacific Southwest Forest and Range Experiment Station, Forest Service, USDA, Berkeley, CA.

Boe, K. N., no date. *Research at the Redwood Experimental Forest*. Pacific Southwest Forest and Range Experiment Station, Forest Service, USDA, Berkeley, CA.

Branch, W. C., and D. J. Lewis, 1964. *The California Coast Redwood*. The Resources Agency, Sacramento, CA.

Buckman, F. O., and N. C. Brady, 1960. *The Nature and Properties of Soils*. Sixth Edition, The McMillan Co., New York, NY.

Caldwell, M. M., and J. H. Richards, 1989. "Hydraulic Lift: Water Efflux from Upper Roots Improves Effectiveness of Water Uptake by Deep Roots," *Oecologia* 79:1-5.

Citizens for a Redwood National Park, 1965. *Statement of Policies and Program*. No address; dittoed.

Clawson, M. 1963. Land and Water for Recreation; Opportunities, Problems, and Polices. Rand McNally, Chicago, IL

Commonwealth Club of California, 1962. "Taxation Principles to Encourage Reforestation." *The Commonwealth* II(XXXVIII)3. San Francisco, CA

Connaughton, C. A., 1963. "Natural Resources in America's Future," paper presented at the 12 Annual Conclave, Association of Western Forestry Clubs, Humboldt State College, Arcata, CA.

Corker, C. E., 1959. "The Issues in *Arizona v. California*," *Proceedings* of the Western Resources Conference, University of Colorado, Boulder, CO.

Corps of Engineers, 1963. *Interim Report for Water Resources Development, Eel River, California*, US Army Corps of Engineers, San Francisco, CA.

Dana, S. T., 1956. *Forest and Range Policy: its' Development in the United States*, McGraw-Hill Book Co., Inc., New York NY.

Dana, S. T., and K. B. Pomeroy, 1965. "Redwoods and Parks," *American Forests* 71(5):3-32.

Dasmann, R. F., 1965. *The Destruction of California*. The McMillan Company, New York, NY

Davis, K. P., 1954. *American Forest Management*. The McGraw-Hill Book Co., Inc., New York, NY.

Decker, K., 1957, "Recreation Resources, Economic Aspects," *Appendix Supplement and Natural Resources of Northwestern California Preliminary Report.* Consultants' report to the National Park Service, Pacific Southwest Field Committee, USDI, USGPO, Washington, DC.

Department of Agriculture, 1941. *Climate and Man*. Yearbook of Agriculture, USGPO, Washington DC

Department of Agriculture, 1955. *Water*. Yearbook of Agriculture, USGPO, Washington DC

Department of Public Works, 1964. *Public Hearing Regarding Proposed Freeway Relocation….* Division of Highways, District 1, 430 Wabash Avenue, Eureka, CA.

Department of Water Resources, 1957. *The California Water Plan*. Division of Resources Planning, The Resources Agency of California, Sacramento, CA

Department of Water Resources, 1958, *Water Facts for Californians*. Sacramento, CA.

Department of Water Resources, 1964. *North Coastal Area Investigation*. Bulletin 136, Preliminary (1963) and Final Editions. The Resources Agency of California, Sacramento, CA

Department of Water Resources, 1965. *Flood!* Bulletin 161. The Resources Agency of California, Sacramento, CA

DeWitt, J. W., 1963. *The Fish and Fish Habitats of the Coast Redwood Region in Mendocino, Humboldt, and Del Norte Counties, California*, Consultant Report to the National Park Service, Humboldt State College, Arcata, CA.

Division of Beaches and Parks, 1964. The Redwoods of California. The Resources Agency of California, Sacramento, CA

Division of Forestry, 1959. *Forest Practice Rules for the Redwood Forest District.* Department of Natural Resources, State of California, Sacramento, CA.

Division of Forestry, 1962. *The State Forester's 1962 Report.* Department of Natural Resources, State of California, Sacramento, CA.

Duerr, W. A., 1960. *Fundamentals of Forestry Economics*, McGraw-Hill Book Co., Inc. New York, NY

Eckstein, O., 1958. *Water-Resource Development: the Economics of Project Evaluation*. Harvard University Press, Cambridge, MA

Fisher, R. t., 1903. "A Study of the Redwood," In *The Redwood*, USDA, Bureau of Forestry, Bulletin 38, USGPO, Washington, DC pp. 7-28.

Forest Service, 1940. *Influence of Vegetation and Watershed Treatments in Runoff, Silting, and Stream Flow*. In cooperation with the Soil Conservation Service, a Progress Report of Research, USDA, Miscellaneous Publication No. 397. Washington, DC.

Fritz, E., 1959. *Characteristics, Utilization, and Management of Second-Growth Redwood. Foundation for American Resources Management,* 582 Monadnock Building, San Francisco, CA.

Fritz, E., 1960. *The Life and Habits of Redwood the Extraordinary*, California Redwood Association, 576 Sacramento Street, San Francisco, CA.

Gardner, R. A. 1958. *Soil-Vegetation Associations in the Redwood-Douglas-fir Zone of California*. Proceedings of the First North American Forest Soils Conference, September 8-11, Michigan State University, East Lansing, MI

Geological Survey and Bureau of Mines, 1955. *Natural Resources of Northwestern California: Geology*. Preliminary Report. Appendix to *Natural Resources of Northwestern California*, Pacific Southwest Field Committee, USDI, Washington, DC.

Harding, S. T., 1960. *Water in California,* N-P Publications, Palo Alto, CA.

Harlow, W. M., and E. S. Harrar, 1941. *Textbook of Dendrology*, American Forestry Series, McGraw-Hill Book Co., Inc., New York, NY

Hoffman, W., and S. E. Rantz, 1963. *Floods of December 1955-January 1956 in the Far Western States*, Part II, Stream Flow Data, Geological Survey Water-Supply Paper 1650-B, USGPO, Washington, DC.

Hofsted, E. A., 1961. "Timber Company Adopts Clear Cut System: The ARCO Story." *Western Conservation Journal* March-April.

Hopkins, A. D., 1938. *Bioclimatics*. USDA, Miscellaneous Publication No. 280, Washington, DC.

Jenny, H., 1941. *Factors of Soil Formation.* McGraw-Hill Book Co., Inc., New York, NY

Kramer, P. J.., and T. T. Kozlowski, 1979. *Physiology of Woody Plants*, Academic Press, Inc., New York NY.

Leopold, L. B., *Conservation and Protection*. Conservation and Water Management, Part A, US Geological Survey Circular 414, Washington, DC.

Linsley, R. K., M. A. Kohler, and J. L. H. Paulhus, 1949 *Applied Hydrology*, McGraw-Hill Book Co., Inc., New York, NY.

Loomis, E. W., 1954. *Study of Forest Taxation on Second Growth Timber and Lands in Humboldt County*, Redwood Region Conservation Council, 576 Sacramento Street, San Francisco, CA.

Lull, H. W., 1959. *Soil Compaction on Forest and Range Lands*, USDA, Miscellaneous Publication No. 768, Washington, DC.

Lutz, H. J., 1945. "Soil Conditions of Picnic Grounds in Public Forest Parks." *Journal of Forestry* 43(2):121-7.

Luxford, R. F., 1930. "Distribution of Moisture in Virgin Redwood Trees," *The Timberman*, February.

Lyons, V., 1955. *Tomorrow's Birthright*. Funk and Wagnall's, Co., New York, NY.

McMinn, H. E., and E. Maino, 1959. *An Illustrated Manual of Pacific Coast Trees*, University of California Press, Berkeley, CA.

Meinecke, E. P., 1929. *The Effect of Excessive Tourist Travel on the California Redwood Parks*. State Printing Office, Sacramento, CA.

Miles, J. G., 1963. *The Effect of Commercial Operations on the Future of the Coast Redwood Forest: a Study Prepared for the National Park Service*, 350 E Street, Eureka, CA.

Miller, Jr., N. C., 1963. "California's Loss of Colorado River Water May Force Speed-ups in Costly Projects," *Wall Street Journal*, June 5, p. 15.

National Park Service, 1964. *The Redwoods*. USDI National Park Service, Washington, DC.

Paulson, H., R. Flynn, and G. Konnersman, 1963 (?). *History of Humboldt County Timber Taxation.* Informational material from the Humboldt County Tax Assessor's Office, Eureka, CA.

Peattie, D. C., 1947. *A Natural History of Western Trees*, Houghton Mifflin Company, Boston, MA

Perrey, J. I., 1959. "Suggested Legislation on Flood Plain Regulation," *Journal of the Hydraulics Division*, Proceedings of the American Society of Civil Engineers, pp. 43-51.

Pinchot, G., 1900. *A Primer of Forestry, Part I. The Forest*, USGPO, Washington, DC.

Rantz, S. E., 1964. *Surface-Water Hydrology of Coastal Basins of Northern California*. Geological Survey Water-Supply Paper 1758, USDA, Washington, DC.

Redwood Park and Recreation Committee, 1965. *The Redwood Park and Recreation Plan*. P. O. Box 37, Eureka, CA.

Richards, J. H., and M. M. Caldwell, 1987. "Hydraulic Lift: Substantial Nocturnal Water transport Between Soil Layers," *Oecologia* 73:486-9.

Save-The-Redwoods League, 1961. *The Program of the Save-The-Redwoods League in Humboldt and Del Norte Counties*, 114 Sansome Street, San Francisco, CA.

Save-The-Redwoods League, 1964 (?). *Save the Redwoods*. [One of many brochures issued by the League], 114 Sansome Street, San Francisco, CA.

Shirley, J. C., 1947. *The Redwood of Coast and Sierra,* University of California Press, Berkeley, CA.

Show, S. B., 1932. *Timber Growing and Logging Practice in the Coast Redwood Region of California,* USDA, Technical Bulletin No. 283, Washington, DC.

Sierra Club, 1963. *The Last Redwoods.* San Francisco, CA. [See also review of this publication by Emanuel Fritz in the September, 1964 *Journal of Forestry* 62(9):641]

Smith, W., and C. F. Hains, 1961. *Flow Duration and High- and Low-Flow Tables for California Streams,* USDI, Geological Survey, Washington, DC.

Spinney, W. W., 1963. "Effect of Forest Service Timber Sales and Road Construction on the Watershed," paper presented at meeting of the Eel River Flood Control and Water Conservation Association, Eureka, CA. October 24th.

Sturgeon, E. E., 1963. *Impact of Cultural Features on Redwoods.* Report to the National Park Service, Coast Redwood Project, Humboldt State College, Arcata, CA

Subcommittee on Benefits and Costs, 1950. *Proposed Practices for Economic Analyses of River Basin Projects*. Federal Inter-Agency River Basin Committee, Washington, DC.

Thornthwaite, C. W., and J. R. Mather, 1955. "The Water Balance," *Publications in Climatology* VIII(1):1-104. Centerton, NJ.

Timber Standards Advisory Committee, 1961. *The Appraisal of Timber Property*. Assessor's Handbook, The California State Board of Equalization, Sacramento, CA.

Udall, S. L., 1963. *The Quiet Crisis*. Avon Books, New York, NY.

Vaux, H. J., 1955. *Timber in Humboldt County,* California Agricultural Experiment Station, Bulletin 748, University of California, Berkeley, CA.

Wallis, J. R., 1963. "Logging for Water Quality in Northern California," Paper presented at the Redwood Region Logging Conference, Eureka, CA., March 8th.

Wallis, J. R., 1965. *A Factor Analysis of Soil Erosion and Stream Sedimentation in Northern California*. PhD Dissertation, University of California, Berkeley, CA.

Watson, E. B., S. W. Cody, and A. Smith, 1925. *Soil Survey of the Eureka Area, California*. Bureau of Soils, USDA, In cooperation with the University of California Agricultural Experiment Station, Berkeley, CA, USGPO, Washington, DC.

Weather Bureau, 1961. *Rainfall Frequency Atlas of the United States*. USDC, Technical Paper 40, Washington, DC.

White, D. P., 1958. "Available Water: the Key to Forest Site Evaluation." *Proceedings* of the First North American Forest Soils Conference, East Lansing, MI.

Wiant, Jr., H. V., 1963. *The Ecology of Redwood.* Consultant Report to the National Park Service, Coast Redwood Project, Humboldt State College, Arcata, CA

Wildland Research Center, 1960, 1961, 1962. *Annual Reports: Redwood Ecology Project*. University of California, Berkeley, CA [Unpublished progress reports]

Wisler, C. O., and E. F. Brater, 1949. *Hydrology*. John Wiley & Sons, Inc., New York, NY.

Witmer, T. R., 1956. *Documents on the Use and Control of the Waters of Interstate and International streams*. USDI, Washington, DC.

Zahl, P. A., 1964. “Finding the Mt. Everest of All Living Things,” *National Geographic* 126(1):10-51.

Zinke, P. J., 1960. Sedimentation, Soils, and Micro-climate Studies. 1960 Progress Report. Redwood Ecology Project, Wildland Research Center, University of California, Berkeley, CA.

Zinke, P. J., 1962. Vegetation Chance at Recreation Sites in the Redwood Region. Talk recorded at the 14th Annual Forestry Field School, University of California, Berkeley, CA April 9-13.

Zivnuska, J. A., P. Cox, A. Poli, and D. Personen, 1963. *Economic Development Prospects for the Commercial Forest Resources and Forest Products Industries of California*. School of Forestry, University of California, A Report to the Office of Planning, State of California, Sacramento, CA.