Management Plan

for the

Quinault Reservation

March 26, 1954

by

Kenneth W. Hadley
Forester

John W. Libby
Forest Manager

Approved by

Raymond H. Ritney
Superintendent

TABLE OF CONTENTS

TABLES AND MAPS

INTRODUCTION

A. POLICY

"The Bureau is definitely committed to a policy of sustained yield forest management. In most respects the management of Indian forest is directed toward the same objectives sought in the management of a public forest. There are certain fundamental differences which give rise to different management problems. Indian lands are private property held by the United States in trust for the Indians. They must be managed for the best interests of the Indian owners and in accordance with applicable statutes enacted by Congress. Moreover, by reason of the fact that the Indian forest property is so closely involved with the welfare of the Indian people, any plan of forest management which is devised must take into cognizance of the general Indian problem and be coordinated with the whole Indian Bureau program of social and economic betterment. This necessitates a far greater flexibility in long-term forest management plans than is ordinarily required or considered ideal from a purely technical standpoint. Constant adjustments must be made to meet the immediate pecuniary needs of individual Indians or to facilitate the educational and industrial advancements of the tribes."
(Section 202 of Chapter II of Forest and Range Management of the Indian Affairs Manual).

B. OBJECTIVES OF MANAGEMENT

1. To maintain a forest that will yield a continuous income for the Quinault Indians by stumpage values received from sale of timber on their allotments as well as wages from employment in woods operations.

2. To harvest the remaining old growth timber in such a manner as to insure the establishment of reproduction and to minimize the losses due to fire, windthrow, insects and diseases.

3. To obtain the greatest possible growth from the forest and at the same time leave the smallest amount of growing timber as a permanent capital investment.

C. MANAGEMENT PLAN

The Forest Officer's reports of the "Proposed Sale of Timber on the Taholah, Queets, and Crane Creek Logging Units" dated November 15, 1945, and written by Carthon R. Petrie and Perry E. Sharrs stated that it is planned to operate the forest of the Quinault Reservation as a pulpwood property with cedar poles a secondary production on a rotation of sixty years.

1. Acknowledgments

This Management Plan has incorporated material from the following Reports:

a. Forest Officer's Report covering the Proposed Sale of Timber on the Taholah, Queets, and Crane Creek Logging Units on the Quinault Indian Reservation, Washington, dated November 15, 1948, and written by Carthon R. Petrie and Perry S. Skarra.

b. Forest Officer's Report covering the Proposed Sale of Timber on the Crane Creek and Queets Logging Units, dated November 9, 1950, and prepared by John W. Libby and Earle R. Wilcox.

c. Report on Status of Cut-over Land, Quinault Indian Reservation and written by Earle R. Wilcox in January 1947.

d. Indian Forest and Range by J. P. Kinney.

2. Plan Revision

This Plan will be revised not later than January 1, 1959, to incorporate new information accumulated during the intervening period. By 1959 a sufficient number of allotments should be cut on the Crane Creek and Taholah Units to enable a corrected estimate of the remaining virgin timber.

The yield tables resulting from the studies conducted by Dr. Walter H. Meyer are in the process of being revised by George H. Barnes of the Pacific Northwest Forest and Range Experiment Station. A revised bulletin is due for release sometime during 1954. The volumes of these revised yield tables are expected to exceed those used in this Plan and should be included as soon as the bulletin is released.

Emergency revisions will be conducted in event of:

a. Substantial losses of timber from fire, windthrow, insects, disease or other causes.

b. Drastic changes in economic conditions within the forest industries.

I. PHYSICAL ASPECTS OF THE QUINAULT RESERVATION

A. Area, Location and Date Established

The Quinault Reservation, largest of those under the jurisdiction of the Western Washington Agency, is located in extreme Western Washington, lying adjacent to that portion of the Pacific Ocean north of Grays Harbor and south of Destruction Island. Both of these reference points are frequently mentioned in earlier history of Washington Territory.

Prior to negotiations relative to the relinquishment of land by the United States for the exclusive use of the Quinault Indians, a rather large part of this coastal area of Washington Territory was being used by the Ozette, Clallam, Hoh, Quileute, Quaets, and Makah Indians. This area is roughly described as follows:

> Beginning at a point on the coast referred to as "Ozette" or lower Cape Flattery, thence easterly to the Summit of the Olympic Mountains, thence southerly along the crest of this range to the divide between the Chehalis and Quinault Rivers, thence westerly along this ridge, which would lie between the Humptulips and Quinault Rivers to the Pacific Ocean - to a point near or slightly south of the present Moclips River, and thence northerly along the coast to the point of beginning.

A treaty between the United States and the Quinault Indians was negotiated somewhere on the Quinault River July 1, 1855, concluded at the city of Olympia, January 25, 1856, ratified by the Senate, March 8, 1859, and proclamation issued by the President of the United States under date of April 11, 1859.

The treaty provided for setting aside or reserving a tract of land sufficient for the needs and for the exclusive use of the Quinault Indians, and in accordance with this provision a survey of such tract was initiated September 16, 1861. A brief description of the tract so set aside is as follows:

> Beginning at a point on the south bank of the Moclips River at the Pacific Ocean, thence east a distance of 5 miles, thence north 28° W - on a course approximately parallel with the coast - to a point on the North Bank of the Quinault River, thence west to Cape Elizabeth, and thence southerly along the coast to the point of beginning.

This survey of 1861 only enclosed an area of approximately 26,000 acres which was evidently not considered sufficient for the needs of the Indians, and reflected an erroneous interpretation of the terms of the treaty of 1855, as an executive order was issued by President Grant in 1873 to set aside additional lands for the exclusive use of the Quinault Indians, and a new boundary was established in 1892 by Henry L. Fitch, Deputy Surveyor, under contract from the General Land Office. Four years later, or during 1902, the north and south boundaries were retraced and subdivision of townships completed by George R. Campbell, Deputy Surveyor. These surveys, which were accepted and approved by the General Land Office, definitely established the boundaries of the Quinault Reservation as they now exist, briefly described as follows:

> Beginning at the Pacific Ocean at a point on the south bank of the Moclips River - as established by survey of 1861 - thence east 5 miles to that point also established on the original surveys, - thence north 37° 55' East to the most southerly part of Quinault Lake, thence around the shore line to that point farthest northwest on the Lake Shore, thence north 72° 24' west to a point slightly north of the Queets River, thence north 82° 38' west to a point on the Pacific Ocean north of the mouth of the Queets River. Total distance from point of beginning to northwest corner approximately 55 miles. The western boundary extends from this point south along the Pacific Coast at low water mark to southwest corner. The Reservation is located entirely within Grays Harbor and Jefferson Counties, Western Washington.

Area - Statistical Information

Gross Area of Reservation (including water) - - -	196,645 acres
Gross Land Area - - - - - - - - - - - - - - -	189,621
Alienated Lands - - - - - - - - - - - - - - -	15,454
Net Area of Reservation - - - - - - - - - - -	174,167
Tribal Land Including Reserves - - - - - - -	4,064
Trust Alloted Lands - - - - - - - - - - - - -	170,080
Reserved by United States - - - - - - - - -	23

* See Map No. 3 for Land Ownership

B. Topography and Drainage

The topography of the Quinault Reservation is gently rolling on that portion south of the Quinault River with the average elevation being 200 feet above sea level.

North of the Quinault River the Crane Creek and Quinault Lake Units are level to moderately rolling in character, being broken only by gently sloping stream valleys and occasional small knolls. In these Units there is only one area which can be said to be badly broken or precipitous. In the case of the Quinault Lake Unit it is limited in extent and occurs in the Northwest corner of the Unit.

The northern portion of the Crane Creek Unit covers approximately 3,000 acres. This area is badly broken by numerous sharply defined stream courses, and is also very precipitous with elevations ranging from 600 to 1,650 feet within distances less than a mile.

The topography of the Taholah Unit and the Proposed Quaets Unit are characterized by extremely elaborate drainage systems and broken terrain. On neither of these Units is the total range in elevation great, amounting to only about 700 feet in elevation from sea level to the highest knolls in the eastern portion of the Units. However, there is scarcely a square mile within either Unit that is not traversed for some distance by at least one stream and some sections are broken by several. Each of these streams represents a break in terrain and some of these are sharp, being marked by drops of one hundred to three hundred feet in the short space of five to ten chains.

The Reservation drains principally through four major streams and their tributaries. The Quaets and Raft rivers drain the Northern portion of the Reservation, the Quinault river with its tributaries drains the central and major part of the Reservation and the Moclips river near the southern boundary drains a portion of the southern part.

Within the Reservation there are large areas of poorly drained land supporting a cedar type of vegetation and occasional meadow areas of moderate size where a dense ground cover of sedges and shrubs thrive under the acid conditions which exist.

* See Map No. 1 for Topography features of the Reservation.

C. Geology and Soils

In most of the area along the Pacific Coast extraneous outcroppings of sedamentary character are to be found which differ greatly from similar deposits in other parts of the Western states. This is termed by Geologists as the Hoh formation, and is a composition of sandstone, shale, and conglomerate. The bedrock has been covered rather unevenly with clay, sands and gravels of fluvial origin, mostly resting in a horizontal position. It is only where streams and tributaries have carved their channels that the underlying bed rock has been exposed, though natural barriers of erosion have occurred by reason of wind and surf in prominent headlands along the coast. The original covering of the basic formation has through the years been supplemented by a top layer of humus created by reason of the luxurious growth of herbaceous shrubs and plants which are prevalent throughout the area.

The depth of this topsoil varies greatly, reaching its maximum at the lower elevations on bottom lands adjacent to the main streams.

With logging operations being confined in the past largely to the lower elevations and generally comparatively level areas and the rapid ability of the land to produce cover after the original forest cover is removed little erosion has been observed on the Reservation.

However, forest operations are now moving into the more broken and precipitous areas of the Reservation and while soil erosion has been only slight in the past, future effects may be somewhat less desirable.

D. Climate

The Reservation is in the "fog belt" which is characterized by heavy precipitation, high humidities and moderate temperatures. Climatic conditions are very favorable for tree growth and the establishment of reproduction.

Average annual rainfall varies from approximately 85 inches near the coast to 125 inches in the vicinity of Lake Quinault. The following table indicates the approximate percentage of the annual rainfall occurring during each month of the year:

January	15.20 %
February	11.89
March	10.38
April	6.73
May	4.63
June	3.46
July	1.25
August	1.61
September	4.78
October	8.89
November	13.67
December	15.51 %
	100.00 %

As indicated above nearly 1/2 of the annual precipitation falls during the months of November, December and January. July and August are the driest months. Nearly all the precipitation falls in the form of rain. Temperatures are moderate with no records below zero degrees Farenheit being recorded. The temperature seldom exceeds 100 degrees Farenheit. The average growing season without frost is 180 days. Precipitation Tables will be found on Page_____.

Complete or nearly complete windthrow is not a common occurrence. There have been some notable exceptions such as "The Big Olympic Blowdown" of 1921 when losses were tremendous. Normally, in the virgin stands losses due to windthrow are confined to occasional scattered trees or small areas.

The following table shows the ten highest wind velocities for the years 1941 through 1944 as recorded by the U. S. Coast Guard on Tatoosh Island.

Date	m.p.h.	Direction
1941		
Dec. 15	71	SW
Dec. 16	62	S
Dec. 27	61	E
Jan. 17	59	S
Nov. 24	59	S
Nov. 29	59	S
Nov. 13	57	S
Dec. 8	56	S
Dec. 1	55	S
Dec. 4	53	SW
Dec. 18	53	SW
Dec. 22	53	S
1942		
Nov. 2	74	S
Jan. 7	62	E
Dec. 21	59	S
Jan. 6	57	E
Mar. 16	54	S
Apr. 16	53	SW
Feb. 1	50	E
Nov. 14	50	S
Nov. 15	49	S
Feb. 2	48	E
Mar. 5	48	W
Dec. 30	48	S

Date	m.p.h.	Direction
1943		
Oct. 23	64	S
Jan. 4	58	S
Feb. 1	57	SW
Jan. 3	55	E
Jan. 25	54	E
Oct. 16	54	S
Apr. 1	51	S
Dec. 18	51	S
Mar. 24	50	S
Apr. 23	50	NW
1944 (To June 30)		
Mar. 22	53	S
Jan. 1	50	W
Feb. 21	50	NW
Feb. 8	48	E
Jan. 17	48	S
Jan. 4	45	S
Jan. 13	45	S
Mar. 9	44	W
Jan. 16	43	S
Jan. 9	43	E

These are "maximum velocities", measured over five-minute periods.

Precipitation - Quinault Ranger Station

1906 - 1952

Weather Records Taken Since 1906:

	HIGH	YEAR	LOW	YEAR
January	50.39	1935	3.62	1949
February	29.77	1932	2.39	1930
March	24.96	1908	4.18	1926
April	14.66	1950	2.27	1933
May	14.16	1948	0.40	1922
June	12.50	1920	0.09	1922
July	6.87	1932	T	1922 & 1937
August	7.77	1950	0.12	1928
September	19.66	1946	1.50	1908
October	24.66	1947	3.14	1926
November	42.39	1909	2.78	1936
December	31.52	1917	3.71	1951
	278.99"		24.15"	

Annual Avg. 126.75

High: 169.22 - 1933
Low: 79.21 - 1929

ANNUAL RAINFALL RECORDED BY THE MONTH AT HOQUIAM, WASHINGTON

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1901	9.49	11.10	7.18	8.04	4.25	2.85	1.45	.35	4.65	4.37	19.09	11.41	84.[illegible]
1902	6.76	22.41	10.97	5.14	4.35	3.06	1.33	.42	5.13	6.21	15.17	18.95	99.[illegible]
1903	8.35	5.60	6.78	5.92	6.90	5.48	1.40	.84	5.36	5.48	19.75	9.53	81.[illegible]
1904	13.48	15.07	15.66	5.62	.47	2.18	1.70	.17	1.02	3.92	15.84	11.89	86.[illegible]
1905	12.21	6.01	11.93	1.90	4.52	4.41	.45	1.66	7.60	11.60	7.06	14.69	84.[illegible]
1906	12.29	8.66	5.16	2.94	3.83	5.14		.58	8.26	11.01	16.22	11.22	85.[illegible]
1907	11.05	9.08	7.14	5.56	2.70	1.60				2.34		17.54	
1908	10.95	9.01	15.27	7.61	4.95	1.84	.12	2.59	.27	5.48	11.09	10.72	79.[illegible]
1909	14.21	14.75	7.28	2.09	4.23	1.72	2.45	1.26	1.54	7.04	26.76	8.18	91.[illegible]
1910	14.37	10.13	6.59	5.38	3.50	3.31	.29	.47	4.36	10.08	15.31	12.32	86.[illegible]
1911	10.55	4.93	3.94	4.41	8.12	1.41	.80	.77	3.98	4.09	16.97	9.76	69.[illegible]
1912	16.74	10.47	3.12	2.60	3.89	3.61	1.34	3.98	4.16	6.82	12.65	12.62	81.[illegible]
1913	15.90	4.71	6.19	4.59	3.69	6.40	1.78	1.08	6.27	5.50	17.58	7.44	81.[illegible]
1914	23.48	6.48	5.43	6.28	2.15	2.72	.19	.47	7.05	9.84	13.44	4.42	81.[illegible]
1915	8.99	6.28	6.25	4.74	6.46	.60	2.02	.37	1.59	9.22	11.86	17.25	75.[illegible]
1916	5.18	13.18	21.75	4.56	4.12	1.94	5.33	.10	1.59	3.24	10.53	7.77	79.[illegible]
1917	9.08	7.53	10.61	9.20	.94	3.60	.82	.50	3.44	1.63	5.10	24.93	77.[illegible]
1918	10.44	10.76	8.72	2.86	2.52		.82	3.90	.07	6.74	10.33	14.62	71.[illegible]
1919	14.49	10.88	10.23	6.15	4.01	1.71		.32	3.12	1.92	10.50	7.96	71.[illegible]
1920	10.35	.82	10.09	6.49	3.26	2.96	1.12	2.20	9.44	13.20	8.92	13.86	82.[illegible]
1921	13.14	12.22	6.70	7.95	2.41	5.57	.06	2.12	4.31	10.70	16.27	9.22	90.[illegible]
1922	4.81	6.17	9.85	5.51	40.05	.57		2.24	4.43	6.86	3.43	14.94	62.[illegible]
1923	17.58	4.55	5.66	4.48	3.30	.10	.70	.05	1.71	5.00	4.83	12.08	60.[illegible]
1924	9.27	12.96	3.29	3.40	.74	1.53	.59	2.09	6.09	13.44	11.10	14.29	78.[illegible]
1925	16.59	11.47	5.40	3.94	1.64	3.21	.42	1.15	1.55	2.60	10.96	14.03	73.[illegible]
1926	10.43	10.46	4.35	2.32	7.91	.08	.20	3.07	3.40	7.55	14.35	13.81	77.[illegible]
1927	15.12	13.10	7.44	6.18	6.56	1.57	.82	3.24	5.99	9.72	19.83	8.28	97.[illegible]
1928	13.69	4.18	8.26	8.26	1.65	.83	.83	.10	2.63	9.66	9.94	10.47	70.[illegible]
1929	3.46	4.54	9.25	7.39	1.64	3.87	1.29	.88	.35	2.57	2.54	12.02	49.[illegible]
1930	8.02	12.63	7.22	7.81	3.65	2.35	.24	.27	4.64	6.52	6.67	6.68	66.[illegible]
1931	15.74	9.24	4.81	5.58	2.47	6.38	.10	.46	7.23	12.04	10.22	17.92	102.1
1932	11.83	15.48	6.86	8.54	2.09	1.16	4.77	1.83	1.93	7.00	19.47	19.92	110.[illegible]
1933	16.85	8.66	2.26	2.47	5.65	2.75	1.22	.69	8.94	11.32	6.99	35.70	113.4[illegible]
1934	19.33	6.16	8.38	2.28	4.81	.75	2.25	1.07	4.44	12.11	14.85	14.91	91.5[illegible]
1935	20.35	8.09	4.86	3.57	1.67	2.60	1.04	1.94	4.36	3.56	6.12	10.02	83.1[illegible]
1936	15.22	12.41	7.13	2.27	6.30	6.01	2.46	2.11	1.33	1.96	1.52	14.52	73.2[illegible]
1937	6.33	14.84	5.27	12.48	3.97	5.91	.16	5.16	3.92	5.89	26.40	18.08	108.[illegible]
1938	9.18	7.72	2.67	9.49	3.32	.22	.37	.64	2.90	8.82	10.55	11.97	77.8[illegible]
1939	16.62	10.46	5.91	2.14	3.58	3.27	1.91	1.12	1.28	5.49	6.51	18.94	77.2[illegible]
1940	7.47	17.27	10.90	7.57	3.39	.34	2.95	1.24	2.73	12.20	9.10	9.87	87.0[illegible]
1941	10.02	4.58	3.03	2.36	6.36	2.72	.10	4.31	7.76	4.94	8.80	15.48	70.4[illegible]
1942	7.31	5.99	5.73	4.10	3.15	4.30	2.72	.23	.64	8.20	12.33	14.16	69.9[illegible]
1943	8.32	8.48	8.17	6.88	3.57	2.16	1.27	3.40	2.16	9.42	4.56	12.35	70.74
1944	9.31	6.59	5.35	7.31	2.55	.54	.36	1.12	5.42	3.50	11.06	4.39	57.50
1945	13.36	9.35	12.27	3.80	5.18	.78	1.14	1.40	3.88	7.01	11.71	13.21	79.04
1946	10.72	13.82	7.30	7.83	.73	4.04	1.95	.33	2.06	7.28	9.34	10.30	75.90
1947	11.90	6.93	5.24	4.34	1.04	5.09	2.57	.84	2.39	15.05	6.45	12.10	73.95
1948	7.06	11.02	5.61	5.38	8.35	1.14	.97	2.35	7.03	5.15	13.28	13.45	80.82
1949	1.92	13.34	5.94	3.92	1.89	1.04	1.46	1.48	2.34	6.25	12.88	13.80	66.22
1950	11.40	16.22	14.63	6.38	1.76	1.01	2.04	2.62	3.47	11.75	11.29	14.10	96.57
1951	13.50	13.85	8.00	1.64	1.96	.24	.53	.10	4.23	10.58	10.09	8.15	72.87
1952	11.10	5.08	5.69	3.89	1.44	2.30	.45	1.90	.78	2.12	3.61	15.05	53.41
1953	28.20	6.08	7.19	5.21	4.51	2.21	.35	2.31	2.26	6.03	10.03	13.63	88.01
												ANNUAL AVERAGE- - -	80.00

II. HISTORY OF PAST OPERATIONS ON THE QUINAULT RESERVATION

Prior to the year 1910 little timber had been cut on the Quinault Indian Reservation. Following the allotting of forested land to individual Indians some arrangements were made between the Indians and the M. R. Smith Shingle Company to sell timber under the pretense of clearing the land for agricultural purposes.

These practices were soon terminated by the Office with instructions that in the future all timber should be sold only in accordance with Departmental regulations. During the years of 1915, 1916 and 1917, a timber survey of the Quinault Reservation was made to determine the valuation of the Reservation.

A. LOGGING CONTRACTS

1. On March 17, 1920, a large block of timber called the Moclips Unit was advertised for sale at minimum prices of $3.50 for cedar, $3.00 for Douglas Fir and Spruce, $2.00 for white pine and $.80 for hemlock and white fir. The Aloha Lumber Company was awarded the contract with a bid of $3.60 for cedar, $3.10 for Douglas fir and spruce, $2.10 for white pine, and $.90 for hemlock and white fir. The contract approved in July of 1920 provided for increases of stumpage every three years basing the revaluation on a study of the Grays Harbor market. In April of 1924 the stumpage value of white pine was increased to $3.00 and hemlock $1.25. The following year the price of hemlock was reduced to $.90 and no additional changes were made during the life of the contract. This Unit, cut between the years of 1922 and 1939, yielded 184,701 M ft. B.M.

2. On December 21, 1921, the Point Grenville Unit was advertised for sale at minimum prices of $2.50 for cedar, $2.25 for spruce and Douglas fir, $1.50 for white pine and $.60 for hemlock and white fir. At the opening of bids on March 30, 1922, the M. R. Smith Lumber Company was awarded the contract by bidding $2.60 for cedar and the minimum for other species. In April of 1926, the price of cedar was increased to $3.00, spruce $2.75 and hemlock $.80. In 1927 the price dropped to $2.80 for cedar. On April, 1929, spruce was reduced to $2.50. In March, 1931, the stumpage on cedar was reduced to the original $2.60 and in April, 1932, all prices were reduced to the original bid. Between the years of 1923 to 1939, 300,149 M ft. B.M. were cut under contract from this timber sale Unit.

3. On April 20, 1922, the Cook Creek Unit was advertised for sale and the minimum prices were set at $2.50 for cedar, spruce and Douglas fir, $1.50 for white pine and $.60 for hemlock and other species. The Hobi Bros. were awarded the contract with bids of $4.35 for cedar, spruce and Douglas fir, $1.50 for white pine and $.80 for hemlock and other species. No increases of stumpage were made. Between the years of 1924 and 1933, 496,447 M ft. B.M. was removed from this Unit.

4. On the 12th of August, 1922, the Quinault Lake Unit was advertised for sale with minimum prices of $3.00 for cedar, spruce and Douglas fir and $.75 for hemlock and other species. This contract called for bids to be made on all timber cut prior to April 1, 1928. Prices subsequent to that date were to be determined by the Commissioner by three year periods. This contract was awarded to the Ozette Railway Co. of Hoquiam, Washington, with bids of $3.00 for hemlock and $5.00 for all other species.

While the contract provided for an increase in stumpage on April 1, 1928, and April 1, 1931, based on log prices, no increases were made because prices actually declined. During the years 1933, 1934 and 1935, no logging was done on the Quinault Lake Unit because of poor market conditions. It became necessary under a special Act of Congress of June 6, 1934, to authorize a modification of the existing contract reducing the stumpage on the Unit. This contract modification was subject to the approval of the individual Indian owners, the majority of which approved the modification. Some owners refused to sign the contract modification so there were and still exists at the time of this writing two separate stumpage values on the Quinault Lake Unit.

Quinault Lake Logging Unit Changes in Stumpage Values for Modified Contracts

	Bid Price	Year 1923	1936	1942	1943	1944	1945	1946	1947	1948
Cedar	$ 5.00	$5.00	$3.00	$4.00	$5.00	$5.10	$5.50	$5.50	$6.90	$9.50
Douglas Fir	5.00	5.00	3.25	4.25	5.00	5.65	6.00	6.00	6.35	8.90
Spruce	5.00	5.00	3.25	4.25	5.60	6.30	6.30	6.30	6.30	8.60
Hemlock	3.00	3.00	1.00	1.75	2.25	2.25	2.25	2.25	2.50	3.50
White Pine	5.00	5.00	3.00	4.00	4.00	4.25	4.65	4.65	4.95	6.75
Amabilis Fir	5.00	5.00	1.00	1.75	2.25	2.25	2.25	2.25	2.65	3.50

	Year 1949	1950	1951	1952	1953	1954	1955	1956	1957
Cedar	$10.00	$ 9.55	$12.80	$13.05	$10.40				
Douglas Fir	11.80	11.45	13.60	14.65	15.15				
Spruce	9.00	7.30	9.80	10.60	10.95				
Hemlock	4.00	3.65	4.10	4.35	4.60				
White Pine	7.50	9.00	8.60	8.25	9.80				
Amabilis Fir	4.00	3.65	4.10	4.35	4.60				

Unmodified Contracts

	Bid Price	Year 1923	1943	1946	1949	1952	1955
Cedar	$ 5.00	$ 5.00	$ 5.00	$ 5.00	$10.00	$13.05	
Douglas Fir	5.00	5.00	5.00	6.00	11.80	14.65	
Spruce	5.00	5.00	5.60	5.60	9.00	10.60	
Hemlock	3.00	3.00	3.00	3.00	4.00	4.35	
White Pine	5.00	5.00	5.00	5.00	7.50	9.25	
Amabilis Fir	5.00	5.00	5.00	5.00	5.00	5.00	

The original contract was extended in the modification for 10 years from March 31, 1942 to March 31, 1952. The extension was approved on the 10th of April, 1942. Again in 1950 the contract was extended until March 31, 1957.

Between the years 1923 to 1953, 573,126 M.B.ft. of timber had been removed with approximately 64,000 M ft. B.M. remaining to be cut.

5. The Mounts Unit was advertised for sale in February 1923, with the Aloha Lumber Company being awarded the contract at the minimum prices of $3.50 for cedar, spruce and Douglas fir, $1.50 for white pine and $1.00 for hemlock and white fir.

Stumpage Prices Received

	Bid Price	Year 1923	1942	1943	1944	1945	1946	1947	1948
Douglas Fir	$3.50	$3.50	$4.00	$4.[illegible]	$5.40	$5.75	$5.75	$6.05	$8.50
Spruce	3.50	3.50	4.25	5.60	6.30	6.30	6.30	6.30	8.80
Cedar	3.50	3.50	3.50	4.00	4.15	4.35	4.55	5.55	7.60
White Pine	1.50	1.50	4.00	4.00	4.25	4.65	4.65	4.95	6.75
Hemlock	1.00	1.00	1.75	2.25	2.25	2.25	2.25	2.65	3.50
Amabilis Fir	1.00	1.00	1.75	2.25	2.25	2.25	2.25	2.65	3.50

Between the years of 1928 and 1949 the Unit yielded 236,048 M.ft.B.M.

6. The Hall Unit was advertised on October, 1947, and was sold to the Aloha Lumber Company under a contract approved March 19, 1928, at the minimum prices of $2.50 for cedar, spruce, Douglas fir and white pine and $1.00 for other species. These prices were maintained until 1943 when increases were made.

	Bid Price	Year 1943	1945	1947
Cedar	$2.50	$3.47	$4.45	$5.55
Douglas Fir	2.50	3.17	5.75	6.05
Spruce	2.50	5.25	5.95	6.05
White Pine	2.50	3.94	5.15	5.50
White Fir	1.00	1.75	2.25	2.65
Hemlock	1.00	1.75	2.25	2.50

7. The Hatch Unit was advertised March 19, 1927, and was sold to the Aloha Lumber Company at the minimum prices of $1.50 for white pine, white fir $1.00, cedar $3.50, spruce $3.50, Douglas fir $3.50 and hemlock $1.00. These prices remained in effect throughout the life of the contract. This Unit cut out 25,910 M ft. B.M. of saw timber during the years of 1927, 1928 and 1929.

8. The Upper Freek Creek Unit was advertised for sale on May 7, 1927, and purchased by the Aloha Lumber Company at the minimum prices of $1.50 for white pine, $1.00 for white fir, cedar, $3.50, spruce $3.50, Douglas fir $3.50 and hemlock $1.00. The prices remained in effect throughout the life of the contract with 26,557 M ft. B.M. being removed from the Unit between the years of 1927 and 1939.

9. On July 8, 1942, a contract was approved for sale of the Quinault Bend Unit to the Aloha Lumber Company at the minimum prices of $5.00 for Sitka spruce, $4.25 for Douglas fir, $1.75 for hemlock and $2.00 for dead spruce. This Unit was cut out during 1942 with 2,890 M. ft. B.M. of saw timber being removed.

10. A Tract known as the Milwaukee Unit was sold in August, 1937, to Frank Morgan at $3.78 for Douglas fir and cedar, $3.25 for spruce and white pine and $1.00 for hemlock and white fir. The minimum advertised stumpage was set at $3.00 for live Douglas fir, $2.00 for dead Douglas fir. This Unit cut out 20,747 M ft. B.M. of saw timber with cutting being completed in 1942.

11. On June 17, 1943, the Aloha Lumber Company was awarded the contract to a block of timber designated as the H.P. Trail Unit with bids of $5.00 for Sitka spruce, $6.00 for Douglas fir, $4.00 for cedar, and $1.75 for hemlock and amabilis fir. In May of 1944 the price of spruce was increased to $5.35, Douglas fir to $6.25, cedar to $4.15. Between the years of 1943 and 1947 this Unit cut 42,243 M ft. B.M. of saw timber.

12. The Boulder Creek Unit estimated to contain 41,700 M ft. B.M. was offered for sale under oral or sealed bids on the 25th day of May, 1949. The minimum prices set in the advertisement were $10.20 for cedar, $10.00 for Sitka spruce, $10.90 for Douglas fir, and $5.80 for hemlock and other species. This contract provided for quarterly stumpage adjustments at fixed ratios to the weighted average log prices as quoted from the combined Grays Harbor-Puget Sound log markets in their "Composit Sales Analysis" - Grays Harbor Logging Companies and Composit Sales Analysis Puget Sound Logging Companies. No bids were received on the day of the sale for this Unit.

Negotiations with the Wagar Lumber Company of Aberdeen, Washington, resulted in the signing of the contract on February 18, 1950, accepting the same conditions as advertised in 1949.

Stumpage Values by Quarterly Adjustments

	1950				1951			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Cedar		$10.10	$12.42	$12.99	$13.29	$13.28	$13.61	$12.62
Sitka Spruce		9.18	10.24	10.63	10.82	11.15	11.03	10.84
Douglas Fir		9.80	10.71	11.66	12.12	12.15	12.52	12.39
Hemlock		4.99	5.37	5.70	5.87	6.03	6.12	6.25

Stumpage Values by Quarterly Adjustments (Cont'd.)

	1952				1953			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Cedar	$12.06	$11.10	$10.09	$10.11	$10.20	$10.00	$10.00	$10.06
Sitka Spruce	11.02	11.22	11.32	11.50	11.46	11.29	11.28	11.39
Douglas Fir	12.57	12.52	12.65	12.98	12.91	12.84	12.96	12.93
Hemlock	6.25	6.38	6.54	6.62	6.53	6.45	6.57	6.53

	1954				1955			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Cedar	$							
Sitka Spruce								
Douglas Fir								
Hemlock								

This contract will expire on or before April 1, 1955. To date this Unit has yielded 43,057 M ft. B.M. with an estimated 17,000 M ft. B.M. remaining to be logged.

13. Taholah Logging Unit: Original bids for this Unit were to be received, sealed or oral, by July 8, 1949. At that time no bids were received for an estimated 360,000 M ft. B.M. advertised at the minimum rates of $9.75 per thousand feet B.M. for Western red cedar; $8.75 per thousand feet B.M. for Sitka spruce; $10.85 per thousand feet B.M. for Douglas fir; $3.80 per thousand feet B.M. for Amabilis fir; $6.75 per thousand feet B.M. for Western white pine; $3.90 per thousand feet B.M. for Western hemlock and other species; and $.03 per linear foot for Western red cedar poles.

In April of 1950 the Aloha Lumber Company presented an offer for the purchase of the timber accepting the terms of the original advertisement.

Taholah Unit Stumpage Adjustments

	1950 Quarter				1951 Quarter			
Species	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Cedar			$11.08	$12.42	$12.70	$12.69	$12.91	$12.06
Sitka Spruce			8.96	9.30	9.20	9.75	9.65	9.48
Douglas Fir			10.66	11.80	12.06	12.09	12.46	12.33
Amabilis Fir			3.74	3.95	4.01	4.11	4.24	4.23
White Pine			6.66	7.47	7.78	7.27	7.99	8.02
Hemlock & others			3.61	3.83	3.95	4.05	4.11	4.20

	1952 Quarter				1953 Quarter			
Species	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Cedar	$11.53	$10.61	$ 9.65	9.66	$ 9.75	$10.35	$10.39	$10.10
Sitka Spruce	9.65	9.82	9.91	10.06	10.03	9.87	9.87	9.96
Douglas Fir	12.51	12.56	12.59	12.91	12.84	12.78	12.89	12.86
Amabilis Fir	4.15	4.21	4.48	4.46	4.39	4.41	4.49	4.39
White Pine	8.24	8.30	8.43	8.51	8.53	8.52	8.50	8.15
Hemlock and others	4.20	4.29	4.40	4.45	4.39	4.34	4.41	4.39

Taholah Unit Stumpage Adjustments (Cont'd.)

Species	1954 Quarter 1st	2nd	3rd	4th	1955 Quarter 1st	2nd	3rd	4th
Cedar	$							
Sitka Spruce								
Douglas Fir								
Amablis Fir								
White Pine								
Hemlock and others								

14. At the sale of the Crane Creek Logging Unit held on September 23, 1949, a bid at the minimum prices set in the advertisement was received from Rayonier, Incorporated. The minimum prices were cedar $10.75, Sitka spruce $9.75, Douglas fir $13.40, Amablis fir $6.00, white pine $7.60, hemlock and other species $5.90 and .035 per linear ft. for cedar poles. Adjustments of stumpage values were to be made by applying fixed ratios established at the bidding and the market prices at the time of the sale. However, Rayonier, Incorporated, failed to execute a contract for the purchase of the Crane Creek Unit and the Secretary of the Interior notified the Corporation that the $163,000 deposit with the bid would be retained as damages. This amount was then distributed among the allottees in the Crane Creek Unit.

Again on June 17, 1952, the Crane Creek Unit was opened for bids by oral auction. Rayonier, Inc. bid the minimum prices of $13.30 for cedar, $10.60 for spruce, $15.00 for Douglas fir, $6.65 for Amablis fir, $8.60 for white pine, $6.40 for hemlock and other species and $.055 per linear ft. for cedar poles.

Crane Creek Stumpage Adjustments

Species	1952 Quarter 1st	2nd	3rd	4th	1953 Quarter 1st	2nd	3rd	4th
Cedar				$10.67	$ 10.85	$11.19	$11.46	$11.20
Sitka Spruce				11.50	11.28	11.18	11.03	11.27
Douglas Fir				15.63	15.67	15.45	15.43	15.43
Amablis Fir				7.15	7.02	7.11	7.19	7.05
White Pine				9.48	9.43	9.45	9.03	8.85
Hemlock & others				6.77	6.93	6.90	6.98	6.87

Species	1954 Quarter 1st	2nd	3rd	4th	1955 Quarter 1st	2nd	3rd	4th
Cedar								
Sitka Spruce								
Douglas Fir								
Amablis Fir								
White Pine								
Hemlock & others								

15. Quoets Logging Unit: On August 12, 1949, designated as the date of an oral auction sale of this Unit, no bids were made for the timber which was estimated to be 467,000 M ft. B.M. of saw timber. The minimum stumpage rates to be considered were: $7.50 per thousand feet B.M. for western cedar; $7.70 per thousand feet B.M. for Sitka spruce; $5.80 per thousand feet B.M. for Douglas fir; $3.60 per thousand feet B.M. for Amabilis fir; $5.85 per thousand feet B.M. of Western white pine; $3.50 per thousand feet B.M. for Western hemlock and other species and $.025 per linear ft. for Western red cedar poles.

Unlike the Taholah and Crane Creek Logging Units, improving market conditions during the year following the sale brought no offers from timber interests. This Unit is the only area of virgin timber on the Reservation not under a timber sale contract.

* For Locations of various Logging Units see Map No. 2 on Page_____.

* For Cutting Operations Map by Decades consult Map No. 3 on Page_____.

B. BRIEF FIRE HISTORY

Forest fires of the past have covered a considerable part of the cut over lands of the Reservation. These past burnings have created a serious problem in as much as statistics shown by the report on reproduction status of cutover lands indicate that approximately 11,000 acres are now in need of replanting. Listed below is the area burned by years on the Reservation starting with 1924 when the first serious fire occurred.

Year	Acres Burned	Year	Acres Burned
1924	10	1939	0
1925	1,200	1940	4
1926	85	1941	15,640
1927	100	1942	0
1928	4,560	1943	0
1929	0	1944	0
1930	60	1945	0
1931	6,360	1946	0
1932	3,600	1947	0
1933	9,030	1948	10
1934	11	1949	1
1935	900	1950	1
1936	34	1951	5
1937	3,880	1952	0
1938	930	1953	130

The combined area of all fires on the Quinsault Reservation has been 46,551 acres. Many of the acres represented by this total have been repetition of areas burned over from one to three times; the total area of land which has been burned over on the Quinsault amounts to 22,400 acres.

* See Map No. 4 for Combined Areas of Old Burns.

C. PAST-CUTTING PRACTICES

"High lead" and "Steam skidder" yarding methods have been used extensively throughout the history of logging operations on the Reservation. In recent years tractor yarding has been increasing in importance but is limited by topographic features as well as soil and weather conditions. While steam units have not been in use since 1952, Diesel yarders continue to predominate the logging "shows" on the Reservation.

With the advent of tractor yarding on the Reservation during the late 1930's attempts were made to deviate from the subscribed practice of clear cutting, and tree selection methods were attempted.

A report on tree selection logging and selection of areas to be reserved from cutting dated September, 1949, and written by Perry E. Skarra, discussed the status of seventeen selectively cut areas varying in size from thirty acres to over 1,000 acres. The areas were considered to be representative of timber types on the Reservation. Permanent sample plots were established which were examined periodically or until they were destroyed.

The conclusions reached in this report were that tree selection in the old growth, virgin timber stands is not feasable on the Quinault Reservation except in very limited locations and then only under the most favorable conditions.

Of the seventeen areas only four showed anything but negative results. The more successful areas are as follows:

1. Pure stand of Douglas fir on favorable ground:
   This stand contained thrifty second growth with a scattering of old growth. The old growth was removed and a light cut in the second growth was made, taking a total of 30% of the stand. The remaining stand has proven to be wind firm and good growth has been indicated in the residual stand. This would indicate that tree selection is feasable where the residual stand is Douglas fir and the ground favorable. Unfortunately, stands of this type are extremely limited on the Reservation.

2. Original timber type old growth Douglas fir with second growth hemlock and thrifty second growth fir and limited amounts of spruce, cedar, and Amabilis fir:
   This area was selectively logged in 1937, removing all old growth timber, snags, and windfalls. Approximately 40% of volume and 30% of trees were removed. All hemlock selected for the residual stand was riddled by wind storms. A relatively small area of the second growth fir proved wind firm and remains standing.

3. In the Quinault River Bend Unit 353 acres were logged selectively by tractor in 1942 and was marked to favor young thrifty spruce in residual stand. Wind-throw in the higher areas was observed but for the most part the area has retained the residual stand very well especially in the river bottom area.

4. An area in the old Hall Unit marked for tree selection as an example in cedar type:
Residual stand was cedar and hemlock. This area was logged in 1943-45 and showed light to moderate windthrow with the heaviest damage being done to the hemlock. It was pointed out that the trees in this area were short boled and much of the residual was of short pole size.

The four above-mentioned areas which responded somewhat favorably to tree selection can be applied only in such rare cases on the remaining stand of timber as to be of little importance. The other thirteen areas were damaged so severely by windthrow that it was necessary to carry out numerous salvage operations in an attempt to save the windthrown timber.

D. DISEASES, INSECTS AND PESTS

Blister rust of pines caused by rust fungi of the genus Cronartium is very destructive to the white pines on the Reservation. Seedlings, saplings and small poles are especially attacked.

White pine comprises less than two percent of the timber stands and has been of no more value than other species which will eventually replace the pine.

*Ribes bracteosum is evidently the principal alternate host occurring in abundance over much of the area. The high, dense, almost impenetrable brush occurring in the streams and swampy areas would create an extremely difficult and expensive eradication project.

Red ring rot, ring scale, red heart or peaky heart rot caused by the ring scale fungus Fomes pini is responsible for more losses than any other decay. This rot affects all conifers on the Reservation and is confined principally to the old growth timber. Logging operations wherever practical should be directed to the overmatured stands.

A developing infestation of the fir engraver beetle (Pseudohylesinus spp.) in the true firs of eastern Washington was noted in 1949. The outbreak occurred first in the Mt. Baker National Forest and later on the west side of the Olympic Peninsula. Infestation has been detected one mile from the northeast side of

the Reservation in the Olympic National Forest but has not been encountered on the Reservation at this time.

Most serious damage occurs in mixed stands and particularly where there is a high percentage of overmature and decadent timber. With salvage logging being the only practical method of control for this insect, close contact is being kept with its spread. Logging operations at the present time are in the heart of the silver fir stands along the northern end of the Crane Creek Unit. In the event the area is seriously attacked cutting can be quickly initiated.

The Black-headed Budworm, Acleris variana became prevalent on the Olympic Peninsula in 1944. The insect was noted to attack all conifers with hemlock and silver fir the preferred host in that order. Mature trees, second growth and understory trees are all readily attacked by the budworm. Infestation resulting in moderate defoliation of hemlock was noted in 1945 near the village of Quaets.

Several infestations of the hemlock looper Ellopia fervidaria have been recorded on the Olympic Peninsula. The most recent heavy infestation occurred during 1939 and some damage was noted near the village of Quaets.

Damage of the Sitka spruce weevil Pissodes sitchensis has been noted in increasing abundance since 1950. The weevilling has occurred principally on Sitka spruce in the reproduction of the poorly stocked stands. Trees between the ages of five and thirty years are principally affected.

The black bear has been very destructive to young pole-sized stands of Douglas fir. By clawing away the bark and then devouring the soft meristematic tissue of the cambium layer the tree is killed or damaged severely.

The damage has been particularly severe on the poorly-stocked areas. The fifteen-year old Douglas fir on these areas are important as future seed source to restock these areas. The bear by eliminating or severely damaging these trees is greatly retarding the restocking of the areas and the rotation period.

During the fall hunting season of 1951 the meat wastage regulation was waived concerning the bear and in 1952 the bear was declared a predator in the general area of the Olympic Peninsula.

Control of the bear population is evidently the only means of protecting these young stands.

E. PLANTING

Under the dates of July 11, 1929, and December 17, 1929, the Department reserved 1,980 acres of logged and burned over tribal land for administrative purposes, setting this land aside as the " uinault Forest Experiment Station" and gave its approval to the plan of artificially reforesting the land.

Planting was begun in 1929 by the forestry organization and was completed in 1934 as a CCC-ID project. This planting included spruce, Douglas fir, white pine, western cedar, Port Orford cedar and redwood. This planting was very successful. A part of this plantation was burned in the 1941 fire.

The following table shows the status of the experimental station as indicated by A. C. Hauge's report on the "Proposed Tree Planting Projects".

Acres planted 1929-1934 - - - - - - - - - - - - - - - - - -	1070
Natural reproduction - - - - - - - - - - - - - - - - - -	45
Area burned in 1941 fire - - - - - - - - - - - - - - - -	380
Swampland and Unmerchantable timber at time of logging-	485
Total Area - -	1980 acres

To make additional areas available for planting, allottees owning land in the Red Creek watershed of the Reservation were solicited and seven allotments totaling 320 acres were deeded to the U. S. Government in trust for the Quinault tribe for reforestation purposes. In 1940 as a CCC-ID project 480 acres were planted on these allotments. Consent to transfer was obtained from owners of nine more allotments totaling 720 acres but the transfer of these allotments to the tribe was not completed.

This was the last planting project on the Reservation and this was burned over and destroyed in the 1941 fire.

III. TIMBER INVENTORY

A. METHOD OF RE-DETERMINING PRESENT VOLUMES OF OLD GROWTH TIMBER ON THE QUINAULT RESERVATION

Past operations on the Quinault Reservation have shown that the actual cut as compared to the original cruise estimates have resulted in an overrun of approximately 67%. Therefore, it was obvious that a continued use of the 1916 cruise as a basis for management plans could not be considered.

During the early part of 1950 Mr. Earle Wilcox assisted by Robert Metzger and Kenneth Hadley completed a summary of timber cut by years on the Quinault Reservation. The work showed the volumes and values cut each year by species. The total annual cut was broken down to show the amount cut from each timber sale unit during the year.

The purpose of this project was two-fold: An easily obtainable account of timber volumes and values of timber removed; and a re-determination of the remaining volumes of virgin timber. The latter was derived after analyzing the past cutting experience by species and applying a percentage adjustment to the existing cruise figures.

Throughout this analysis the values accepted tended to be conservative. It was pointed out that certain factors are present which will increase the percentage of overcut above the estimated increased volumes. The final adjusted volumes were based entirely on the past record of cutting as compared to the cruise. Limited conservatism in volume estimates is preferable to overestimation based on hasty assumptions. Conservatism provides a margin of safety in the determination of allowable cuts. However, extremely conservative volumes as indicated by our existing cruise records cannot be accepted as the basis for determination of such factors as the annual allowable cut during the remainder of the first rotation. The economy of the area, and particularly the economy of the individual Indians with allotments in the uncut portion, require the maximum possible annual cut from the Reservation.

Factors tending to increase the ultimate realization above that of the adjusted volumes are:

(1) Increased standards of utilization in the wood-using industries. At the time of the cruise the volume estimates were based on the timber that would be used by the industries at that time. It is interesting to note that one of the men in the cruising party who worked the area south of Queets indicates that during the cruise all #3 hemlock logs were culled. Similarly, the poorest grades of logs of other species were not entered as part of the volume of the areas covered. At present these grades are accepted by the operators, and receive their full scale when sound. The degree of utilization at present exceeds that obtained at any time during the past and we may reasonably expect further improvements. Consequently, the percent overcut should increase very appreciably over that recorded in the past.

(2) More rigid standards of scaling are in effect now and will undoubtedly continue (in keeping with increased utilization standards). Much of our record of cut is based on scaling methods that tended to favor the purchaser during the depression period of the 1930's. It was not until 1949 that all "automatic" 4-foot deductions from the butts of hemlock logs were eliminated. Also, such practices as dropping all fractional inches in diameter measurements have only been dispensed with totally during the past five years, with the diameter being accepted as the nearest inch. (Those diameters with fractional parts of an inch over ½ inch are raised to the next higher inch). Such scaling practices will increase the recorded amount to be cut in the future.

(3) It is expected that the poorer stands of timber, which contain a higher percentage of lower grade logs, will bring a greater percent overcut than the better stands. A much larger percent of the total volume of the better stands were considered merchantable in 1916, and thus appears in our cruise volumes. (Comparison of percent overcut on our units completed to date confirms this supposition that a larger overrun factor is found in the poorer stands). Accordingly, since the remaining virgin timber is of poorer quality than the areas previously cut, we may reasonably expect the percent of overcut to exceed the average overcut to date which we are accepting as the basis data for computing our adjusted volumes.

(4) Increased volume due to growth should be a noticeable factor. The common conception is that a virgin stand is considered static insofar as growth is concerned. This is basically true since losses by windthrow, decay, and insects tend to compensate what growth might be added. On the Quinault Reservation windthrow has taken the most severe toll of timber. This windthrow, although occurring to a certain extent each year is most destructive in severe storms which occur only once or twice during a long period of years. The latest of such storms to take an extreme toll of timber was 1921, although less severe storms have occurred several times since. The effect of the storm of 1921 to compensate for growth of previous and subsequent years was eliminated, to a great extent, by having a re-cruise made of those areas striken most severely by this storm. Thus, a great part of nature's way of balancing growth with destructive forces is eliminated by the adjustment of our timber estimate (by re-cruise) to eliminate a large portion of such destruction; while no means has been attempted to adjust our data to provide for the increase due to growth. It is expected that the increase in volume due to growth during the period from 1916 until 1950 would be considerable.

The adjusted volumes were obtained in the following manner:

A table as shown on the following page was constructed whereby the volumes removed by species were shown for each unit. These volumes were shown as (1) estimated volumes based on the 1916 cruise and (2) the actual volumes as removed from the sale areas as indicated by scale reports of individual allotments.

The table included all timber sale units completed by 1950 with the exception of the Point Grenville Unit which was omitted because much of the original estimated volume later became alienated and was not included as part of the final cut.

The table resulting from these entries showed a considerable variation of overcut by species. It was, therefore, felt that a more accurate picture of the volumes remaining in our virgin stands would be calculated by applying a correction factor obtained for each species to the estimated volumes of each such species remaining. These corrected volumes by species were then totalled to give the adjusted value of all timber remaining in the Taholah, Crane Creek and Queets Units. With the exception of approximately 64,000 M Bd ft. of virgin timber on the Quinault Lake Unit which should be depleted by 1957 and 17,000 M Bd. ft. of timber on the Boulder Creek Unit which should be removed by 1955, all remaining virgin timber will be located within the boundaries of the three Units mentioned above.

B. VOLUME OF REMAINING OLD GROWTH TIMBER

1. The following Tables indicate the estimated volumes remaining by Units as of December 31, 1963:

Table I - Quinsault Lake and Boulder Creek Logging Units

" II - Taholah Unit

" III - Crane Creek Unit

" IV - Proposed Queets Unit

" V - Summary of All Units by Species

" VI - Total Volume and Area Remaining Uncut

QUINSAULT LAKE LOGGING UNIT and BOULDER CREEK LOGGING UNIT

Volumes Cut and Volumes Remaining by Species for Quinsault Lake and Boulder Creek Logging Units

SPECIES	QUINSAULT LAKE LOGGING UNIT		BOULDER CREEK LOGGING UNIT	
	Volume Cut to Dec. 31, 1953	Estimated Volume Remaining Dec.31, 1953 M Bd.Ft.	Volume Cut to Dec. 31, 1953	Estimated Volume Remaining Dec.31, 1953 M Bd.Ft.
Pine	1,729,960			
Amabilis Fir	567,260	7,885		
Cedar	103,445,390	8,800	1,777,650	
Spruce	109,179,300	7,830	779,780	
Douglas Fir	110,492,170	3,170	1,168,010	
Hemlock	246,255,670	36,630	39,331,160	17,000
Pulpwood	1,455,660			
TOTALS	573,125,610	64,315	43,056,600	17,000

II

TAHOLAH LOGGING UNIT

Tribal Land 287 acres
Allotted Land 30,034
30,321 acres

416 Allotments

SPECIES	Percent Cut Expected to Exceed 1916 Cruise Estimate	Cruise Volume M.Bd.Ft.	Expected Cut M.Bd.Ft.	Volume Removed From Unit as of Dec. 31, 1953	Volume Remaining Dec. 31, 1953 M.Bd.Ft.
Cedar	58	360,000	569,000	33,569,670	535,000
Sitka Spruce	67	43,000	72,000	16,789,710	55,000
Douglas Fir	40	3,000	4,000	1,918,380	2,000
Amabilis Fir	- 7	42,000	39,000	6,899,370	32,000
White Pine	181	7,000	20,000	1,568,290	19,000
Hemlock	92	90,000	173,000	21,948,140	151,000
Cottonwood				36,990	
TOTAL Saw timber		545,000	877,000	82,724,750	794,000
Cedar Poles (Linear Ft.)		5,000,000			

-22-

III

CRANE CREEK LOGGING UNIT

Tribal Land 166 acres
Allotted Land 35,216
35,382 acres

473 Allotments

SPECIES	Percent Cut Expected to Exceed 1916 Cruise Estimate	Cruise Volume M Bd.Ft.	Expected Cut M Bd.Ft.	Volume Cut 1953	Volume Remaining Dec. 31, 1953 M Bd.Ft.
Cedar	58	330,000	521,000	11,108,950	510,000
Sitka Spruce	67	16,000	27,000	100,460	27,000
Douglas Fir	40	10,000	14,000	49,450	14,000
Amabilis Fir	- 7	86,000	80,000	1,576,930	78,000
White Pine	191	7,000	20,000	112,590	20,000
Hemlock	92	165,000	317,000	4,208,800	313,000
TOTAL		614,000	979,000	17,157,160	962,000

Cedar Poles (Linear Ft.) 1,320,000

IV

PROPOSED CUTTING UNIT

Tribal Land 411 acres
Allotted Land 40,672
41,083 acres

555 Allotments

SPECIES	Percent Cut Expected to Exceed 1916 Cruise	Cruise Volume M Bd.Ft.	Expected Cut M Bd.Ft.
Cedar	58	273,000	431,000
Sitka Spruce	67	32,000	53,000
Douglas Fir	40	1,000	1,000
Amabilis Fir	- 7	78,000	73,000
White Pine	191	7,000	20,000
Hemlock	92	76,000	146,000
TOTAL Saw timber		467,000	724,000

Cedar Poles (Linear Ft.) 3,500,000

VOLUMES OF VIRGIN TIMBER REMAINING ON THE
QUINSAULT RESERVATION AS OF DECEMBER 31, 1953
M Bd.Ft.

UNIT	Cedar	Sitka Spruce	Douglas Fir	Amabilis Fir	White Pine	Hemlock	Total
Queets	431,000	53,000	1,000	75,000	20,000	146,000	724,000
Crane Creek	510,000	27,000	14,000	78,000	20,000	313,000	962,000
Taholah	536,000	55,000	2,000	32,000	19,000	151,000	794,000
Quinault	9,000	8,000	3,000	8,000		36,000	64,000
Boulder Creek						17,000	17,000
TOTALS	1,485,000	143,000	20,000	191,000	59,000	663,000	2,561,000

VI

ESTIMATED VOLUME REMAINING OF OLD GROWTH TIMBER ON THE QUINAULT RESERVATION
M Bd.Ft.

UNIT	Volume	Area Remaining to be Cut
Quinault Lake	64,000	1,800 Acres
Boulder Creek	17,000	720 "
Taholah	784,000	28,641 "
Crane Creek	962,000	35,182 "
Queets	724,000	41,083 "
	2,551,000	107,426 Acres

C. CHARACTER OF REMAINING VIRGIN TIMBER

The remaining timber stands vary widely in both quality and character over the remaining uncut portion of the Reservation but are predominantly the cedar-hemlock type with Amabilis fir, Sitka spruce, white pine and Douglas fir occurring in lesser volumes. Cedar is the most abundant and is the most generally distributed being found in varying degrees of mixture over the entire area except for occasional pure hemlock stands along the eastern boundary of the Crane Creek Unit. The hemlock attains its greatest abundance in the Crane Creek Unit. The occurrence of species is shown by the following table:

Cedar	Sitka Spruce	Douglas Fir	Amabilis Fir	White Pine	Hemlock	Total
57	9	1	8	2	23	100

The Crane Creek Unit supports the best quality of timber remaining on the Reservation. Due primarily to its wide distribution cedar reflects the greatest variation in quality reaching from "Very Good" in some parts of the Crane Creek Unit and the eastern and central parts of the Quoets Unit to almost worthless "Flat-tail" cedar in the swamps and along the beach area of the Quinault and Quoets Units. There is some variation in the quality in the other species but is less extreme, the poorest stands being found near beaches in the Quoets and Taholah Units where exposure to ocean storms has transformed and repressed the trees.

Hemlock which occurs next to cedar in order of abundance is generally distributed throughout all three Units with its heaviest incident in the Crane Creek Unit where it is found in almost pure stands of considerable extent. It ranges from "Very Good" in the Crane Creek Unit to "Very Poor" on the coast in the Taholah and Quoets Units, but generally throughout the three Units it is of good average quality. Amabilis fir is found third in order of abundance in the Quoets and Crane Creek Unit and fourth on the Taholah Unit. It has rather a broad distribution and is generally of better than average quality.

Spruce is found third in order of abundance on the Taholah Unit and fourth on the Quoets and Crane Creek Units. Although, on the latter its incidence is less than one-half percent on the other two Units. The spruce is not as well distributed as Amabilis fir, being found principally along the Quinault river, in the Taholah and Crane Creek Units, south of the Quoets river in the Quoets Unit and along the beach strip in the Taholah and Quoets Units. Throughout the three Units it is of average to better than average quality.

White Pine and Douglas fir have only a limited distribution and occur in only small amounts. The two together comprise only three percent of the volume of each Unit. The largest volume of Douglas fir is found on the Crane Creek Unit; very little on the Taholah Unit, and only an occasional tree in the Quaets Unit. The Douglas fir that does occur is generally large, old growth of high quality with a good percentage of peeler logs.

The white pine which is widely but thinly scattered is of average to poorer than average quality. There is a scattering of cottonwood and alder along some of the stream courses but the volume is small and at the present time not considered as significant.

D. SITE QUALITY

The ability of a forest land to produce timber is determined by climate, soil, topography and other features. This ability is referred to as site and in Western Washington five site quality classes, each representing a range of 30 site indicies, are used for quick approximate ratings.

Little specific information is available concerning site quality on the Reservation. The remaining timbered lands vary from I to V and while the site is somewhat lower than that of the lands already cut over, it should average Site III. The corresponding site index for Site III is 140.

IV. STATUS OF CUT-OVER LANDS

A. EXTENT AND LOCATION

Cutting as noted earlier was first undertaken on a large scale in 1928 and has progressed since then until at the present time approximately 62,000 acres of forest lands have been cut over and over two and one quarter billion board feet of timber removed. Most of this cutting has been done on the southern portion of the Reservation in the area south of the Quinault River. The Quinault Lake Unit, upon which logging operations are nearing completion, includes cut-over lands on both sides of the river in the east end of the Reservation. The Boulder Creek Logging Unit, which is south of the Quinault River, is now in the process of being cut.

With the completion of these Units in 1957 and 1955 cutting operations for the first rotation, excepting for small salvage sales, will be confined to the three remaining units: Taholah, Crane Creek and Queets (Proposed). As of today the Quinault River largely marks the boundary between the cut and uncut areas on the Reservation.

* Consult Cutting Operations Map No. 3 on Page_____.

B. REPRODUCTION SURVEY

In 1944 a reproduction survey was initiated on the cut-over lands of the Reservation in an effort to determine the precise status of these lands and provide a better basis for planting and management planning. This work was carried on at intervals and a report was prepared on the findings in 1947.

The Area south of the Quinault River is of high average site quality, the large part of it falling in Sites II and III, and is potentially one of the best timber producing areas on the Reservation; it also constitutes the biggest problem in connection with development of a long range program for the Quinault Reservation forest. It amounts to nearly one third of the 160,000 acres of good commercial forest lands, and an even larger portion of the potential growing capacity, yet much of it is most inadequately stocked at the present time. Much of this poorly reforested area is the result of serious forest fires which have destroyed the seed sources that seeding in by natural means is now an extremely slow and uncertain process, and many years may be required before reasonably complete stocking can be obtained.

Fortunately, the over-all picture of the cut-over areas, including all lands both north and south of the Quinault River is not as disquieting as the record of past fires and the general lack of good seed source would lead one to expect. In fact, the reproduction status of some of the areas

that have burned over, in some cases several times, is no less than surprising despite the known ability of hemlock to seed in from long distances or under adverse conditions. While the reproduction is not as far advanced as it should be, there are now extensive areas in the cut-over portion south of the river that are fair to well stocked, and there is in addition a substantial planted area in Spruce Orchard now well established. North of the Quinault River the status of the cut-over lands on the Quinault Lake Unit as well as the Milwaukee Trail, and smaller sales, can be considered generally as very good, and all that could reasonably be desired. What is more, the situation appears to be slowly improving by additions each year so that in time areas which are now only poorly stocked may well develop into fair or even good condition. This is not an ideal situation by any means since maximum production requires prompt and complete restocking of cut-over areas, and we do not have this condition nor do we have a good distribution of age classes. It is, however, much better than had been expected after the 1937 and 1941 fires swept over so large a portion of the cut-over area.

From Tables in the 1947 Report and from areas cut in subsequent years, the following summary was prepared:

1. Degree of Stocking

DEGREE OF STOCKING OF CUT-OVER LANDS

Class of Stocking	Area in Acres	Per Cent
I - 70% to 100%	23,385	39.3
II - 40% to 70%	19,392	32.6
III - 10% to 40%	9,870	16.6
IV - 0% to 10%	6,866	11.5
	59,513	100.0

2. Distribution of Area and Age Classes

DISTRIBUTION OF AREA AND DEGREE OF STOCKING BY 5-YEAR AGE CLASS

Five-Year Period	Acres	Class of Stocking I	II	III	IV
1923-1927	2,265	1,160	935	40	130
1928-1932	9,339	3,044	2,735	2,480	580
1933-1937	7,126	1,474	2,094	1,958	1,600
1938-1942	24,256	8,746	7,040	4,310	4,160
1943-1947	8,833	4,522	3,516	583	212
1948-1952	6,004	3,074	2,400	390	140
1953	1,690	865	672	109	44
TOTALS	59,513	23,385	19,392	9,870	6,866

As can be noted from the foregoing, there is a considerable variation in the status of the cut-over lands both in the degree of stocking and the distribution of age classes. Stocking ranges from barren to good and would appear to be rather good on the whole with 39.3 classed as 70-100% stocked, and 32.6 per cent classed as 40-70% or medium. Actually, it will take quite a few years, and an extensive planting project on the Class IV area, before all the cut-over lands will be adequately stocked and in full production, and the second rotation must be delayed and volumes curtailed accordingly. Distribution of age classes by areas is also unbalanced and tends to produce the same results, for there is a serious shortage of areas in the older age classes and a substantial surplus in the 1938-1942 age group. Thus, in effect the second rotation has been delayed by five to ten years beyond the point where it would normally have started.

* For Area Distribution of Age Classes Consult Map No. 5 on Page____.

3. Composition, Age and Site

The average age of the reproduction on the stocked cut-over areas ranges from one to twenty-seven years but will average slightly more than fourteen on an area distribution basis because, though cutting was heaviest between 1928 and 1930, the occurrence of burns since has delayed the inception of reproduction. Site quality on the cut-over areas ranges from I to IV but taken on the whole is better than the general level for the Reservation and will average between II and III. Corresponding site indexes for sites II and III are 170 and 140 which represent the height of the dominants and codominants at 100 years of age. Hemlock has been found to be the dominant species in the cut-over areas and averages nearly 60 percent, while cedar averages about 30 per cent, spruce 7 percent and Douglas fir and white pine 2 and 3 percent respectively. Cedar is somewhat more abundant in the western portion of the Reservation than in the east, probably because of the swampier character of the lands, and in some locations even slightly outnumbers the hemlock. On the whole, however, hemlock is by far the most abundant species and it is anticipated that this dominance will increase rather than diminish as the degree of stocking improves.

C. EXPECTED VOLUMES OF SECOND GROWTH

Predictions of growth are always fraught with uncertainties and especially so when conditions are as diverse as the above data reveal. Not only does the site quality vary from extremes of I to IV, but there is a wide range in the degree of stocking, and also to a lesser degree in the composition by species of the stocking. In addition, there are noticeable differences in soil, exposure, and location with respect to available seed source, which will effect the rate of future stocking and also the relative

mortality. These and other factors will all have some effect on future yields regardless of the effectiveness of protection from fires, and from other destructive forces. Any predictions as to future growth are made under the assumption that sufficient funds will be provided for the adequate protection of the cut-over areas from fire. Without such protection it is impossible to make any predictions of future growth, for the cut-over area south of the river is under serious hazard from fire and will continue to be until it is fully stocked and reproduction is well advanced.

Results of studies conducted by Dr. Walter H. Meyer, and published in United States Department of Agriculture Technical Bulletin No. 544, entitled "Yield of Even-Aged Stands of Sitka Spruce and Western Hemlock," indicate that stands of these species in the fog belt region of the West Coast normally attain their best periodic rates of cubic foot growth prior to 60 years of age, and their best mean annual growth rate at slightly over 60 years of age on average sites. Culmination of volume growth at this age indicates that the Quinault Indians will be most benefitted by a rotation of 60 years which should give them the most satisfactory growth rate return on their tree capital providing the management objective is maximum pulpwood production. If, however, the production of saw-timber is the object, it would be necessary to extend the rotation for an additional forty or fifty years when the maximum mean annual board foot growth rate is reached. It is believed that the interests of the owners will be best served by managing the Reservation forest for pulp and cedar pole production, which in this type of forest where hemlock (a valuable pulp species) predominates, will give the most rapid turnover on tree capital commensurate with the rate of return. We are, therefore, predicting our following conclusions on this method of management and on an approximate rotation of sixty years.

In the same bulletin Dr. Meyer presents increment tables to show the mean annual cubic foot increment per acre of trees 2.6 inches and larger in diameter, and the mean annual board foot increment per acre of trees 11.6 inches and larger in diameter, for the various site index classes at ten-year intervals of age. These tables reveal that fully stocked stands of site index 140 are capable of producing a mean annual increment of 197 cubic feet per acre at the age of 60 years, and a mean annual board foot increment of 742 feet at the same age. Making due allowance for degree of stocking, variation in stand composition, and an exceptional mortality because of windthrow, from the normal fully-stocked stand of site index 140, we estimate that the partially to fully stocked cut-over lands will produce an average of 585 board feet per acre per annum, and 154 cubic feet of wood at an age of sixty years.

In order to estimate the total volume of second growth timber available for harvesting at the beginning of the second rotation, the foregoing average of 525 board feet per acre per annum has been applied to the total area of Class I and Class II reproduction by five year age classes as shown in the preceding table of distribution of area and degree of stocking into five year periods from which reproduction could start. The following table of expected volumes available for cutting at the beginning of the second rotation has been set up in five year periods to correspond with the periods in which reproduction is assumed to have started.

EXPECTED VOLUME OF SECOND GROWTH TIMBER
AVAILABLE FOR CUTTING DURING 5-YEAR PERIODS
AT THE BEGINNING OF THE SECOND ROTATION

5-Year Period	Area W.Satisfactory or better stocking	Total Volume for Harvest During Period Based on Mean Annual Increment of 525 Bd.Ft/Acre/Year	Average Volume/Year Available for Harvest During Period
1983-1987	2,095	65,992,500 Bd.Ft.	13,198,500 Bd.Ft.
1988-1992	6,279	197,788,500 " "	39,557,700 " "
1993-1997	3,568	112,392,000 " "	22,478,400 " "
1998-2002	15,786	497,259,000 " "	99,451,800 " "
2003-2007	8,038	253,197,000 " "	50,639,400 " "
2008-2012	5,474	172,431,000 " "	34,486,200 " "
Total Second Growth Timber Available for Cutting During 1st 30 years of Second Rotation - - - - - - - - - - - - - -		1,099,060,000 " "	
Average Second Growth Cut Per Year - - - - - - - - - - - -			63,302,000 " "

To compare with the above expected volume of second growth timber available for cutting during the second 60 year cutting period on the Quinault Reservation, it is well to examine the potential capacity of the Reservation for growing timber. The gross area of the Reservation is 189,621 acres of which 15,454 acres have been alienated, leaving 175,159 acres still in Indian ownership. Of this net Indian area 174,217 acres is classified as forest and woodland, but approximately 15,000 acres of this is in swamp, prairie, and open lodgepole pine, so that actually there is only about 160,000 acres that can be classed as true commercial forest lands. If we assume, as we reasonably can, since the average site quality on the commercial forest lands is Site III, that the forest will produce an average of 525 board feet per acre per annum during a 60-year rotation period, we have a total potential annual growth of about 84,000,000 feet per annum. However, we can only hope to reach this rate by slow degrees by reason of the seriously understocked condition of some 16,000 acres of the cut-over lands, so that the annual growth that can actually be expected is about 76,000,000 board feet.

Actually, the expected growth during the first half of the second rotation falls far below the latter figure because of the serious delays in the establishment of satisfactory reproduction by recurring fires which have burned over some 22,400 acres one or more times and have delayed the start of reproduction on some areas by as much as 15-19 years. It is principally because of those fires that such a large portion of the cut-over lands are understocked. Gradually, as these barren and understocked lands become fully stocked and as the effects caused by delay in the start of reproduction have been compensated by reduced cuts during the first half of the second rotation, we can expect the annual increment to increase to the point where a cut of 80 to 90 million feet can be maintained annually on a sustained-yield basis and a sixty-year rotation. Adequate protection funds to carry the cut-over lands through the initial period of about twenty-five years after cutting are, of course, an absolute essential to the attainment of this objective.

V. INDICATED CUTTING PROGRAM

A. FUTURE SALES

At the present time the proposed Quoets Unit is the only area of virgin timber not under contract. Sale of this Unit is contemplated for some time in 1956 or 1957. It will be necessary to postpone any further attempts to sell the Unit until the Boulder Creek and Quinault Lake Units are completed and personnel can be released to administer an additional timber sale unit.

Two complete Forest Officer's Reports have been made on this Unit, one in 1948 and another in 1950. The major portion of any future report concerned with the proposed sale of the Quoets Unit can be readily obtained from the "Forest Officer's Reports" indicated in the acknowledgments of this Management Plan.

1. Stumpage Evaluation and Revaluation

The ratio procedure, included as a part of the Patric-Skarra "Forest Officer's Report" of November 15, 1948, has been accepted as proper for the periodic adjustment of stumpage rates on the Taholah, Boulder Creek and Crane Creek Logging Units. It is anticipated when the Quoets Unit is sold that the ratio procedure will be used to establish the fair market stumpage prices for timber on the Unit.

B. CUTTING METHOD

Logging operations will progress through the remainder of the old growth timber by a system of block selection. Past experience has shown that well stocked stands of timber or advanced reproduction provide the most effective fire break in recent cut-over lands. The cutting will be directed with respect to width and direction in relation to the seed source, as to assure alternate strips of green timber and cut-over land, with no great unbroken distance of cut-over area in any direction. Such a program requires close cooperation between the purchaser and the Indian Service and necessitates the operators presenting a plan of operations for each year's cut at least two months prior to the time set for starting the planned operations.

C. DEPLETION SCHEDULE

Based on experience with past sales it is anticipated that a minimum of thirty-three years will be required to complete cutting on the Taholah Unit. The Crane Creek Unit is expected to require a minimum of thirty-five years as is the proposed Quaets Unit. Considered realistically, it is more likely that the actual cutting period will run more closely to forty years because of the conservative volume estimates and some volume gains through growth during the contract periods. It is also probably that future business conditions will duplicate to some extent those of the past quarter century of operations on the Reservation, which, because of circumstances beyond the control of the operators, have required contract extensions. The growth predictions have been calculated conservatively and are more likely to exceed the indicated yields than under-run.

The following table is included to show anticipated volumes to be removed from existing and expected timber sale units during the next five years:

PROJECTED CUTTING FOR PERIOD 1954 to 1959

UNITS:	Quinault Lake	Boulder Creek	Taholah	Crane Creek	Quaets (Proposed)	TOTAL
Year		Millions of Feet, Board Measure				
1954	25	12	27	28		92
1955	25	5	27	28		85
1956	14		27	28		69
1957			27	28	20	75
1958			27	28	20	75
1959			27	28	20	75

After 1959 the annual cut should level off and remain at a constant annual cut of about 75 MM Bd Ft. per year until the year 1963 when it is anticipated the Taholah Unit will be completed. It is expected that the Crane Creek Unit will be completed during 1987 and the Quaets area during 1992.

AVERAGE YEARLY CUTS AVAILABLE-MM FT B.M.
AT END OF 60-YEAR ROTATION

UNITS:	Taholah	Quaets	Crane Creek	Second Growth	TOTAL
Year					
1963	27	20	28	13	75
1964-1987		20	28	13	61
1988-1992		20		40	60
1993-1997				28	28
1998-2002				99	99
2003-2007				51	51
2008-2012				36	36

VI. MANAGEMENT CONSIDERATIONS

A. Ownership Problem

Practically all of the forested land was allotted following the decision against the contention of the government in the case of the United States v. Tommy Payne (264 U.S.446). With the ownership originally distributed among approximately 2,340 individuals any plan of forest management was predestined to encounter serious problems not normally anticipated by managers of forest properties.

One of the greatest obstacles to the development of a sound long-range program for the Quinault Indians has been the extremely diversified ownership of their lands, and the nonresident status of most of the allotment owners. Having very little tribal property and the allotments being largely in the hands of absentee owners, there is very little community interest and the principal concern was, and continues to be, an immediate cash return from their timber. Consequently, there has been a constant pressure exerted to dispose of the Reservation status, irrespective of either forestry, community or industrial considerations, and development of the forest resources on a basis that would set up a prosperous Indian wood industry and community on a permanent basis has received very little sympathetic consideration by the Indians.

This allotted status of the forest land aside from the tremendous task of contacting and gaining the support of individual owners has saddled the forest manager with the problem of bringing all land into full productivity when reforestation involving the expenditure of Federal funds on these allotted lands cannot be practiced.

Ownership consolidation is essential for the successful long term management of the Quinault Reservation. Planting projects and timber stand improvement work are important and necessary tools of forest management, and looking forward into the second rotation, it is obvious that some plan must be devised which will eliminate the heirship enigma and consolidate the property permitting the restoration of the land to its full productivity.

B. Fire Protection

The importance of keeping fire out of cut-over lands cannot be overemphasized. Fires on any forest property are destructive and costly but on forest lands where planting cannot be practiced they assume increased magnitudes.

If fire can be prevented studies as indicated by the reproduction survey show that reproduction will usually establish itself very well. It is, therefor, the duty of the fire organization to confine the serious losses to the past.

There are three lookout towers located on the Reservation. The tower on Lone Mountain gives excellent coverage of the high hazard areas of the Reservation and is the only lookout manned throughout the fire season. The tower near the village of Cuoets is rarely used and the Point Grenville tower is manned only following lightning storms or other periods of emergency.

In addition, the U.S. Forest Service has two lookout towers overlooking the Reservation. All presuppression and suppression activities are organized in the Fire Control Plan for the Reservation. The regular fire plan is analysed annually to determine any changes necessary to provide more complete protection.

Maps accompanying this Management Plan For the Quinault Reservation were included only in the first three copies. The three copies refered to are on file at the Central Office; The Area Office; and the Hoquiam Office.

A PROPOSED PROGRAM OF ACTION

for the

TAHOLAH AND CRANE CREEK TIMBER SALE UNITS

QUINAULT INDIAN RESERVATION

Presented by:

John W. Libby
Forest Manager

A Proposed Program to Improve the Administration and Management of the Taholah and Crane Creek Timber Sale Units on the Quinault Indian Reservation and to Provide for Early Payment to the Indians who own the Allotments in these Units.

SUMMARY

Administration of the Taholah and Crane Creek Timber Contracts on the Quinault Indian Reservation is complicated by the fact that practically the entire area under these contracts is in 862 individually owned tracts of 80 or 40 acres. The problem is:

> "How can we provide the allotment owners with early income from their timber and, at the same time, effect the orderly harvest of that timber in accordance with sound forest management principles?"

The two goals are not compatable. Good forest management requires that the harvesting of the remaining timber on these units be accomplished over a period of 20 or more years by a system of alternate clear-cutting of relatively small blocks or areas, designed to minimize fire danger and provide for natural reforestation of the clear-cut blocks. Many of the allotment owners are advanced in years and will not live to enjoy the benefits of the income from their timber if operations are continued as at present.

The problem is further complicated by the fact that some 49 allotments under these contracts have been fee patented. Fractional interests in at least 55 others have been alienated through inheritance by non-Indians.

The Indian Bureau's administration of the Taholah and Crane Creek sales has been severely criticized by Congress; by the Indians; by the General Accounting Office and others. Measures recommended by both Congress and the General Accounting Office have been taken, insofar as possible, in an effort to improve the situation. Other measures have been initiated by the Bureau of Indian Affairs. None of these measures has helped materially in solving the major problem. We cannot harvest the two billion feet of timber remaining on the two units at a much greater rate than is presently being accomplished.

The only feasible answer to the problem would seem to be:

> "Conversion of the ownership in the allotments on each of these units to a single owner."

Such conversion could probably best be accomplished through acquisition, by the United States of the allotments involved, with provision for eventual

transfer to the Quinault Tribe or, perhaps, to the U. S. Forest Service, if such action should be considered desirable.

Such action would:

1. Cost the Government nothing as acquisition and administrative costs necessary to accomplish the program would be repaid with interest as the timber is harvested.

2. Result in improved management of the forest lands under the contracts.

3. Greatly simplify the administration of the contracts with appreciable savings to the Government.

4. Give all of the allotment owners early payment for their interests in the timber and lands under these contracts.

5. Eliminate serious right-of-way problems.

6. Greatly reduce the clerical workload with resultant savings to the Government.

7. Reduce the cost of the Purchasers' operations and justify a modest increase in stumpage prices.

Acquisition costs to the Government for the allotments under contract and for the timber estimated to be remaining on the allotments as of December 31, 1961, computed at current stumpage prices, would amount to approximately $25,000.000.

The cost of cruising the 862 allotments involved would cost from $150,000 to $175,000. This money could be recovered by withholding from payments made for the allotments. (Estimated at $200 per allotment.)

Additional personnel that would have to be provided by the Forestry, Realty, I.I.M. and Welfare branches at the Western Washington Agency for a period of two to three years might well require an increased budget in those branches of as much as $60,000 a year for a total of $180,000 for the total program. Resulting savings, following completion of the program, should recover this added expenditure within a relatively few years. Or the added cost could be recovered by assessment of a small administrative fee charged against the acquisition cost of the allotments.

THE PROPOSED PROGRAM

I. Objectives

The purpose of this paper is to present in some detail the problems existing in the administration and management of the Taholah and Crane Creek Timber Sale units on the Quinault Reservation and to suggest a possible solution to those problems. As I see it, there are three major objectives to be reached:

1. To provide for improved management of the forest lands covered by these contracts.

2. To provide for greatly simplified administration of the Taholah and Crane Creek timber contracts, with substantial savings to the Government.

3. To provide early payment to the Indians for their interests in the Taholah and Crane Creek Timber Sale Units.

II. Introduction (Historical)

Long term timber contracts for sale of timber on the Taholah and Crane Creek Timber Sale Units, Quinault Reservation, were entered into in 1950 and 1952, respectively. The Taholah Contract expires in 1979; the Crane Creek in 1986, unless extended.

At the time these contracts were made, it was appreciated that there would be serious problems involved in their administration. With the exception of a few hundred acres the total area, of approximately 65,000 acres comprising the two units, consisted of individual allotments, primarily of 80 acres each. There were nearly 900 allotments in the two units and as many as 2,000 allottees and heirs with interests therein.

These people wanted to realize early income from their timber. The timber on the allotments involved was, for the most part, in mature stands. Much of it was decadent. Good forest management demanded that it be harvested as expeditiously as possible.

The latest complete cruise of the timber on the units had been made in 1916. Some supplemental cruise data had been secured with C.C.C. crews during the Thirties. At the time the timber sales were being considered, there appeared

to be no immediate prospect for securing an up-to-date inventory of the allotments.

Following numerous meetings with the Quinault Tribal Council and other interested Indians the decision to proceed with the sales was made. In view of all of the circumstances as of that time the resulting long-term sales appear to have been the best solution that could have been reached. The contracts were entered into, after due advertisement, on the basis of the 1916 cruise even though it was known that the volume of timber to be cut would greatly exceed the volumes shown by that cruise. The old cruise did serve as a basis for immediate sale which was urgently desired by a vast majority of the allotment owners involved and it did provide an equitable basis for assessment of advance payments to be made by the purchasers.

Advance payments were made during the first six years of each contract totalling approximately $2,000,000 on the Taholah Unit and $3,000,000 on the Crane Creek, for a combined total of some $5,000,000. This amounted to an average of about $5,700 per allotment. The owners of the better allotments received substantially more than the average; the owners of the poorer ones, much less. Many whose allotments are located in submarginal cedar areas, received only a few hundred dollars.

A "Sale History" of these two sales was prepared by the writer on April 11, 1960. That history provides statistical information of interest and should be reviewed as part of any present consideration of the Taholah and Crane Creek Contracts.

Page 11 of that report shows a total volume logged on the Taholah Unit of 282,868,000 board feet with total stumpage paid of $3,044,699.

Page 15 gives similar figures for the Crane Creek of 251,153,000 feet logged, with stumpage paid of $3,130,470.

This gives a total income of over six million dollars for timber cut and removed as of April, 1960. As of December 31, 1961, this had increased to about $7,250,000.

Unliquidated balances in advance payment accounts on that date totalled approximately $2,500,000. This means that as of December 31, 1961, the owners of the allotments in the Taholah and Crane Creek Units had received approximately $9,750,000, or an average of close to $11,000 per allotment.

Of the total allotments in the units, a number were fee patented and not included in the sales. Some owners of trust allotments elected to withhold their allotments from the sales. Subsequent to the sale, a number of allottees secured fee patents and successfully negotiated for the sale of their

allotments and contracts to the respective contractors on the two units. The contracts covering these allotments were then terminated. Still others secured fee patents and have either sold to third parties or have retained title themselves. Allotments in this group are still subject to the contracts and continue to be under our administration.

As of this date there are 862 allotments under the two contracts, 49 of which are fee patented. The cutting maps in the appendix of this report show the progress of logging to date. It can readily be seen that many of the owners will have to wait for years for the rest of their money.

In most cases, the money received as advance payments has long since been spent. Many of the allotment owners are well past middle age. Many will not live to receive the remaining value of their timber. (See Exhibit D in Appendix.)

Since the inception of these two contracts, the Bureau of Indian Affairs has been subject to severe criticism - from Congress, from the Indians and from the contractors, in connection with its administration of said contracts. Extensive Congressional hearings were held during the period from 1955 to 1957. While these hearings were concerned with all Federal Timber Sale Policies, the Taholah and Crane Creek sales on the Quinault Reservation drew special attention and severe criticism. A report of the hearing held at Aberdeen, Washington on November 28, 1955, which was chiefly concerned with these two sales, filled 203 printed pages in the investigating Committee's report. A report of subsequent hearings held at Washington, D. C., in April, 1957, devoted exclusively to the sales on the Quinault Reservation, filled one entire volume of 598 pages.

Auditors of the General Accounting Office also made exhaustive studies of our procedures in the administration of these sales. These auditors continue to make regular investigations of our operations.

As a result of the investigations, both Congress and the General Accounting Office have made specific recommendations looking toward improving our procedures. Most of these recommendations have been carried out. We have initiated additional actions to accomplish desired results. The basic problem still remains unsolved. That problem, briefly stated, is this:

> "How can we secure early payment to the Indians of a fair price for their timber, and, at the same time, accomplish an orderly harvest of that timber in accordance with the principals of good forest management?"

There is no simple solution. Even if we were to completely disregard the requirements of sound forest management, the market could not absorb this

timber much more rapidly than it is currently being logged.

With the present ownership of the lands in these units as it is, the Indians can receive their money only as their timber is cut. Inevitably, the last of them cannot be fully paid before 1986 or later.

While the solution is not simple, it can be simply stated:

> "Acquisition of the title to the allotments under contract in the Taholah and Crane Creek Units by a single legal entity."

This might be accomplished in any one of several ways, each of which would require Congressional action. On the following pages I shall bring out in greater detail the need for remedial action and will suggest means by which I believe it can be accomplished.

III. Current Situation

A glance at the cutting maps will show the large area still to be logged in these units. (Also see Exhibit B in Appendix.) It will be noted that a few allotments have been completely logged, a considerable number have been partially logged, but a large majority are still untouched except for the logging roads across some of them. On many of the partially cut allotments, the value of the timber removed has been just about enough to liquidate the advance payment balances. In actuality, therefore, the owners of these allotments are in the same position as those on whose allotments no timber has been logged. They received three advance payments during the first six years of the contract involved and have had nothing since.

Forest inventories of both units have recently been completed. The following table shows the estimated volumes, by species, that remained to be logged as of December 31, 1961:

Species	12/31/61 Crane Creek	12/31/61 Taholah
Western red cedar	787,059 M B.M.	611,388 M B.M.
Western hemlock	392,629 M.B.M.	263,335 M B.M.
Pacific silver fir	94,367 M B.M.	52,255 M B.M.
Sitka spruce	24,559 M B.M.	27,867 M B.M.
Douglas fir	32,865 M B.M.	----------
Western white pine	14,129 M B.M.	7,758 M B.M.
Other	2,413 M B.M.	----------
Total	1,346,021 M B.M.	962,603 M B.M.

It can readily be seen that production from each unit will have to average some 50 million board feet annually if the contracts are to be completed on time. We have recommended that both timber contracts be modified to remove maximum cutting limits in order that the contractors may produce to the limits of their capabilities without contractual restriction.

Even if the maximum cutting limits are removed, it is very doubtful if the purchasers can complete logging of the timber by the expiration dates of the respective contracts. Present available markets cannot be expected to absorb this much production.

On both units there are substantial areas of marginal stands of very low-grade cedar. Much of the timber on these areas is below the merchantability standards prescribed by the timber contracts. On the Taholah Unit, 4,088 acres are classified as small merchantable, 2,615 as non-merchantable, and 83 acres as small hemlock. On the Crane Creek, 5, 452 acres is classified as small merchantable, 2,997 as non-merchantable and 2,621 as pole-size hemlock (H_2). Consideration is now being given to modification of the contracts to provide for revising merchantability standards to include this small, low-grade timber,

principally cedar, at a stumpage price that will make its harvest economically feasible.

Unless some such modification can be accomplished, it will be difficult to justify requiring the contractors to log some of these areas at all. There are trees scattered through them that are merchantable as defined under the contracts. These may occur as single trees or as isolated groups or fringes. In many instances, the merchantable volume to be recovered would not pay for the roads required to reach it, even if it were high quality timber. When it is considered that this timber is primarily No. 3 grade cedar, it can readily be seen that the contractors will be extremely reluctant to log such marginal stands. It can be anticipated they will contend that such stands are non-merchantable and that they cannot be required to log them. I foresee real trouble unless this problem is resolved in the near future.

Since the start of logging on these two units, operations have progressed in accordance with accepted silvicultural practices. This involves a system of clear-cutting alternate blocks of timber progressively through the units. Intervening, un-cut blocks are left as seed sources and fire-deterrants until the clear-cut areas have had an opportunity to re-seed and until the fire hazard, resulting from creation of the logging slash on the clear-cut blocks, has been abated. The reserve blocks are to be logged in succeeding cycles of operations. On neither unit has the first cycle yet been completed, although on the Taholah, this stage should be reached in 1962.

Recent reproduction studies on the clear-cut blocks have revealed that reproduction is not becoming established satisfactorily, particularly on the areas that are predominately cedar. (See Wayne Turner's report on the Taholah Unit, dated March 28, 1961. A similar report is in preparation for the Crane Creek Unit.) It appears that if satisfactory reforestation is to be achieved, natural re-seeding will have to be supplemented by hand planting or by aerial seeding, or both. This presents a further problem because of the ownership status of the lands involved.

As noted above, there are 862 individually-owned allotments included under the two contracts. Of these, 49 have been fee patented and of these, a number have been purchased or inherited by non-Indians. A somewhat larger number have become partially alienated by inheritance. (An exhaustive search of the probate records would be required to determine the number of allotments in this latter category, but there are known to be in excess of 55.)

Since many of the allotments involved were made in the late twenties and early thirties (some allotments were as late as 1933), the heirship problem is not as acute as on most of our reservations. Nevertheless, approximately forty percent of the allotments are in heirship status and on these, multiple ownership is the rule. There are estimated to be nearly 2,000 owners of allotments and interests on the two units.

Measures required to assure that each of these owners receives the proper payment for his interest, add immeasurably to the cost of administering these sales. Property lines must be run around each forty or eighty-acre tract. Log brands must be assigned and stamped on the logs for proper identification as to their point of origin. Brands must be recorded for each load of logs as it leaves the landing in the woods; checked and receipted for at its destination. One clerk is needed almost full time to record and file these load receipts, check them against scale receipts and maintain an account of the results.

Logs have to be scaled and recorded by brands. Separate volumes, by species, must be computed and recorded for each. In an average month's operation there may be as many as 80 or 90 brands for which a separate accounting must be made.

The posting of the individual accounts and the preparation of journal vouchers to effect proper distribution of the stumpage received is a full-time job for one clerk. Also involved, but not generally taken into account, are many hours of work by the Branch of Realty in checking its records to determine the ownerships of the sundry allotments. Every time someone dies, the fractional interests become more numerous.

In addition to the accounting procedures outlined above, many hours are required annually to handle the correspondence with allotment owners and their attorneys concerning their interests in these contracts. Many require complete accountings of the timber cut on their allotments.

Not the least of the administrative problems involved is that of Rights-of-way. Powers of Attorney signed by allotment owners to provide for inclusion of their allotments in these contracts, include the following provision:

> ". . . and I (or we) do also hereby agree to grant any contractor holding any contract hereunder and in conformity herewith, reasonable right-of-way over the above described lands, or any other lands in which I (or we) hold any interest, provided I (or we) shall receive reasonable compensation for any damage done or incurred through such right-of-way. The Commissioner of Indian Affairs or his representative shall definitely determine what shall be considered reasonable damages . . ."

We have operated on the premise that the above clause in the Powers of Attorney constituted the purchasers' right of access to and across the allotments covered by the contracts. Recently, this premise has been challenged and there appears to be some question as to whether the purchasers actually have valid rights-of-way over the allotments under contract.

I believe the operators do have such rights-of-way, but this still leaves the owners of allotments that are not under contract, with no legal access to their allotments. The road systems that have been developed and that will be developed, by the contractors may pass within a short distance of such allotments. Before the timber can be removed from them, the owner (or owners) or the purchaser of the timber must secure a right-of-way over each allotment between this property and the nearest public road. Acquisition of such right-of-way could be so burdensome as to make it impossible to effect any sale of timber.

If rights granted under the Powers of Attorney should be ruled as not constituting valid rights-of-way, the situation would be chaotic. The task of securing formal rights-of-way over 862 allotments for some 400 miles of roads would be enormous. Even though it should be ruled that damages were limited to the value of the timber removed to clear the rights-of-way, the cost of acquisition would be excessive and time required to secure consents of owners would run into months and probably years.

One solution being considered is for the Government to acquire formal rights-of-way over all main logging roads, with recognition being given to prior rights of the contractors during the life of the timber contracts. This would assure continued access throughout the area, following completion of the contracts, for forest protection and management purposes. It would also make it possible for owners of timber not under the contracts to use the roads.

(Difficult and costly as such a program would be, I believe it should be undertaken unless a better solution can be found. However, if the suggestions offered in this memorandum should be adopted, the need for such action would be eliminated.)

As mentioned above, forest management on these units calls for the orderly harvest of the old-growth timber by a system of alternate, clear-cut blocks. This system provides a substantial measure of fire protection by maintaining barriers of green timber between slash areas. It also maintains seed sources, bordering the cut-over blocks to provide for natural reforesting of the logged lands.

Snags are required to be felled in the cut-over areas and recently we have undertaken to reduce excessive slash accumulations by burning.

These practices are all good but they do not go far enough. As stated above, recent surveys of cut-over lands on the Taholah and Crane Units reveal that many of the cut-over areas, particularly the areas of cedar slash, are not restocking satisfactorily. Supplemental seeding and planting is needed if these cedar areas are to be adequately reforested within a reasonable time.

In the past, it has been held that Federal funds could not be used for planting trees on individually-owned lands, and such planting has been restricted to Tribal forest areas. We are presently requesting funds for planting on allotted lands on the Quinault Reservation, hoping for a new interpretation as to the legality of using appropriated funds for reforesting individual allotments. Without such an interpretation, we cannot achieve desired results in the management of these forest lands if the present ownership status is maintained.

We have encouraged allottees to take advantage of the assistance available through the Agricultural Conservation Program to reforest their cut-over lands. A few have expressed interest. None has proceeded with such a program even though we have offered all possible assistance to any who wished to undertake it.

The owners of the allotments under these contracts are becoming increasingly unhappy with the situation. They have owned their allotments for years. They entered into these contracts for the sale of their timber in order to realize an income from that timber. The advance payments made during the first six years of the contracts kept most of them satisfied for as long as the money lasted. That money has long been spent. There can be no more for any allottee until his particular allotment is logged.

Many of these people are advanced in age. Some will wait another twenty years or more before they can receive the remaining payment for their timber. Many will not live to enjoy it.

Each one wants his timber logged now. He cannot understand why only a corner of his allotment is logged and he has to wait at least ten years before more of his timber can be cut; or why a logging road passes through his allotment and none of his timber is taken except that necessary to clear the roadway. Literally thousands of letters have been exchanged with allottees and heirs and their attorneys since the inception of these contracts, concerning this situation (see samples in Appendix, Exhibit D). Our replies rarely satisfy the allotment owners. When a man past 60 is told that it may be 20 years before he will receive further income from his timber, he can hardly be blamed for expressing dissatisfaction.

We have explained the situation through the medium of the Quinault Newsletter and in endless correspondence. The letters continue to come. When we are unable to provide replies that satisfy the writers, they frequently appeal to their representatives in Congress, to the Secretary, the Commissioner, or even the President of the United States. All such correspondence finds its way down through channels to the desk of the Forest Manager who must then report as to the circumstances in each case.

These pressures tend to have an adverse effect on forest management. Whenever feasible, adjustments are made in cutting plans to take care of hardship

cases. This usually calls for a compromise with our concepts of good management. We may be subject to professional criticism for such compromises but it is difficult to deny requests from these people when we know they are in real need. It seems we must continually balance professional forestry requirements against human requirements and frequently, humanitarian considerations outweigh the requirements of good forest management.

Demands by allottees for complete accountings of the transactions involving their allotments add appreciably to our clerical workload. There is no question that they are entitled to these accountings. Every owner of an allotment or interest is entitled to such, but if all demanded it, additional clerical help would have to be employed to render the service.

IV. Proposed Solution

The only real solution to the many vexing problems outlined above is, in my opinion, consolidation of ownership through acquisition of the allotments, either by the United States or by the Quinault Tribe. This is not a new idea. Before either of these contracts was entered into, a number of proposals looking toward such a goal were considered and abandoned. The idea of a co-operative was advanced, but found little response from the allottees. Tribal acquisition was considered. The Quinault Tribe apparently was not interested at that time.

Acquisition by the Forest Service and even by the Park Service was reportedly proposed. Apparently, no one supported such proposals.

I believe a re-examination of some of these proposals is in order. There would appear to be three general ideas to be considered:

1. Acquisition of allotments by the United States.
2. Acquisition of allotments by the Quinault Tribe.
3. Establishment of some form of common ownership through incorporation or formation of co-operatives.

The last named idea does not seem to be too promising. There are over 2,000 interests in allotments on these two units. Since some individuals have interests in two or more allotments, it would require considerable detailed checking of records to determine the exact number of persons involved. The number is somewhere between 1,500 and 2,000. These people are located throughout the United States and Canada. The addresses of many are unknown. To bring any substantial number of them together for a meeting would appear to be out of the question. To handle the matter by mail would be an endless undertaking. Finally, in view of the reaction to such proposals in the past, it is highly probable that only a very small minority of the people concerned would be interested in any such program.

The second idea may be entirely feasible. Heretofore, the Quinault Tribe has shown little interest in acquisition of additional lands, but there are indications that this is no longer the case. It would appear, however, that before the Quinault Tribe should take any action toward the acquisition of real property from which future income is to be derived, it should first establish an accepted list of its members and take such steps as might be necessary to enable it to function as a corporate body, representing such members. It might very well take a number of years to accomplish this.

This brings us to the first suggested idea, which would seem to be the only one whereby the proposed consolidation of ownership could be accomplished expeditiously and within a reasonable time.

I make no attempt to prescribe specific procedures for the implementation of this idea. I do suggest the following general steps that would appear to be logical:

1. Consultations with the allotment owners through the Quinault Newsletter, correspondence, meetings, and personal contacts. I believe a substantial majority would favor the idea.

2. Consultations with the contractors to afford them an opportunity to present their views.

3. Conferences within the Bureau of Indian Affairs to formulate the program and to prepare specific proposals for presentation to Congress.

4. Enabling legislation by the Congress, together with adequate appropriations for getting the job done.

5. Implementation of the program.

The first step would perhaps be the key one. Every reasonable effort should be made to reach every owner in order that each would have an opportunity to express his views. If a substantial majority should favor the proposal, then the other steps should be undertaken.

The second proposed step would be a courtesy to the purchasers. Their acceptance of the proposed program would be desirable, but not essential, as long as the terms of the timber contracts would not be affected. Actually, the contractors could be expected to endorse the idea as its adoption would materially simplify their operations and would permit early liquidation of the still large balances in their advance payment accounts.

Step No. 3 would call for a meeting of minds within the Bureau itself. We should be in a position to agree on the legislation needed to accomplish our

goals. I am primarily concerned with those goals set forth above: Improved Forest Management, Simplified Contract Administration and Early Payment to the timber owners. From the standpoint of the over-all Bureau Program, other goals may be desired.

Eventual acquisition of the allotments by the Quinault Tribe, or perhaps by the U. S. Forest Service, may be desired. Public sale of the cut-over lands upon completion of the contracts would be another possibility. Expansion of the program to make possible the acquisition by the Quinault Tribe of all trust lands on the reservation may want to be considered. (If such an expanded acquisition provision should be included, I would hope that the legislation would provide priority treatment for allotments in the contract interests in allotments that are still partially in trust.

A determination will have to be made concerning administrative fees to be charged the allotment owners, if any. (One suggestion that I believe merits consideration is, that allotment owners be charged for the actual cost of cruising and appraising the allotments but that in no case shall such charge exceed ten percent of the value of the timber on any allotment.)

If this program could be presented to the Congress with the united support of the Indians and the Bureau and Departmental officials concerned, there should be every chance for its enactment into law, particularly when it can be shown that the Government's investment will be recovered with interest; better forest management can be achieved; simplified administration of the contracts will result in appreciable savings; and the allotment owners will benefit immeasurably by receiving early payment for their timber.

The fifth step should be undertaken immediately upon passage of the bill and appropriation of the funds required for inventory and acquisition of the allotments. A major requirement to accomplish this would be to secure inventories of the timber on each allotment in the two units. This could be done by our own staff, but unless we should employ a large temporary staff of cruisers, the time required would be too long. I would propose dividing each of the two units into two parts of approximately equal size, making a total of four areas to be inventoried. It would then be possible to contract with reliable firms of Consulting Foresters or Forest Engineers, with a separate contract for each of the four areas, with such contracts to be completed within 18 months. Our own forest inventory staff would check all contractual operations to assure that contractual requirements were being met, that cruises were within the allowable limits of accuracy, etc.

As inventories on specific allotments were accepted, the acquisition program could be started. This is the point where the other branches of the Agency would come into the program.

Realty, I.I.M., and Welfare would have a greatly increased workload until such time as the program could be completed. Advance planning and budgeting would be essential if the total program was not to be "bogged down" at this state.

I would hope that the entire program could be completed within three years. To do this would require the co-operation of all concerned Branches of the Bureau at all operational levels.

While I have assumed that most of the allotment owners would avail themselves of the opportunity to convert their allotments to cash at the earliest date possible, it must be anticipated that some will not. There may well be some who have no immediate need for money, who will prefer to keep their allotments in their present status under these timber contracts as a reserve for their old age or as an educational fund for their children or grandchildren.

In such cases, action should be taken to acquire such permanent access rights as might be needed over the allotments retained by these people. This situation would bring the Branch of Roads into the program.

Certainly, the proposed program would represent no small undertaking. It would require the all-out efforts of all concerned to carry it to a successful conclusion. I believe those efforts should be made.

V. Conclusion and Recommendation

We in the Forestry Branch at the Western Washington Indian Agency have been attempting to do the impossible. We are expected to accomplish good forest management on the forest lands of the Quinault Reservation to the satisfaction of some 2,000 individual timber owners and, at the same time, to provide each owner with a regular income from his 80-acre allotment from a crop that can only be harvested once in every sixty to eighty years. In the circumstances, I believe we have done a good job and are doing an increasingly better job. But we have not accomplished the impossible.

If the action suggested on the preceding pages could be accomplished, the job would be removed from the realm of the impossible and we would be free to proceed with efficient administration of the Taholah and Crane Creek Contracts in strict accordance with the principles of good forest management.

My only recommendation is that serious consideration be given to the material presented.

John W. Libby
Forest Manager

March 30, 1962

Effects of Wood Products Harvest on Forest, Soil and Water Resources, With Emphasis on Clearcutting in Moist Climates

James H. Patric[1/]

Introduction

Nowhere in the World is there a firmer factual record of how forestry practices affect soil and water than is available for the United States. Forest Service research has led in most of these investigations, but other Federal and State agencies as well as the universities have contributed important new knowledge. Forest Service research concerning forest influences on water resources began about 1910 in the American Southwest, about 25 years later in the Southeast. By 1965, no region in the United States having significant forest resources was without Forest Service and university research programs designed to show both good and bad effects of man's uses of the forest on soil and water resources. A pattern of relatively consistent results has emerged from this accumulation of information.

Effects on Soil

Erosion before wood products harvest

Soils are well protected from erosion by dense strands of mature trees, but even under these conditions some loss does occur. Erosion is a normal geologic process even in uncut forests, most active where annual precipitation ranges from 15 to 30 inches per year (Figure 1). Forest vegetation tends to be scanty and develops slowly in these semi-arid climates. With increasing moisture, vegetation tends to increase in density and vigor. When annual precipitation exceeds 30 inches, soil erosion rates are not further reduced nor do they increase when annual precipitation far exceeds 30 inches. With increasing precipitation more water is available to erode soils, but losses remain at a relatively constant level because vegetation grows most vigorously and densely in wettest regions.

Some generalizations are possible concerning measurements of soil loss in moist climates regions that include much of the forest land in the United States, and most of the commercial timber producing land. Erosion rates up to 0.1 ton per acre per year must be accepted, even in the old-growth forest. This may be considered the geologic norm for moist climate forest and it probably varies from less than 0.05 ton to 0.3 ton per acre per year, depending on geology, soil, climate, and vegetation. Although tons per acre implies a uniform sheet erosion, soil lost from undisturbed forest in moist climates almost always originates in stream channels. Similar generalizations are not possible concerning the geologic norms of semi-arid climate forest except that erosion rates there are always higher.

The key to holding soil loss close to the geologic norm in moist climates is to avoid disturbing the soil and vegetation close to stream channels. The kind, size, or density of trees has little influence on soil erodibility, as long as the forest soil structure

1/ James H. Patric, Northeastern Forest Experiment Station, Timber and Watershed Laboratory, Parsons, West Virginia.

remains relatively undisturbed. Forest soil is virtually armored against erosion by surface accumulations of fresh as well as decomposing leaves and twigs, ranging from three or more tons per acre in southern latitudes of the moist climate region to 12 or more tons per acre in the North. The organic cover is replenished annually by litter fall at rates from 1 or 2 tons per acre. But tree cover may be too sparse in drier regions to produce nearly this much litter. There, the litter cover may be interspersed with grass or even a stony soil surface.

The soil surface cover is the key to minimizing erosion on nonchannel portions of forest watersheds. Litter, minor vegetation, and stones absorb the entire kinetic energy of falling rain, thus preventing compaction and sealing of the surface soil which usually occurs when rain beats down on soil unprotected by a surface cover. Furthermore, water infiltrates rapidly when deep and permeable soil lies beneath this cover, at rates far exceeding rainfall intensity. Infiltration rates of 50 or more inches per hour are common in moist climates while rainfall intensities of more than 2 inches per hour are uncommon. For the simple physical reason that rain almost always is absorbed into moist climate soil faster than it falls, most forest hydrologists hold that surface runoff or overland flow rarely occurs in these regions. Lacking overland flow, there is no mechanism to detach soil particles or to transport them across the forest floor. Only the stream channels, unprotected by litter, always provide sites for active soil erosion in the undisturbed forest. Infiltration rates sometimes are lower in semi-arid climates and overland flow is more common.

But water storage capacity of the soil profile, particularly in wet weather, often is insufficient to contain all of the infiltrated rain. Under these circumstances, the absorbed rain moves laterally through the soil to streams. Forest hydrologists generally agree, where there is adequate surface cover on deep and permeable soil, that complete absorption of precipitation and its subsequent movement through the soil accounts for most forest streamflow, during as well as between storms.

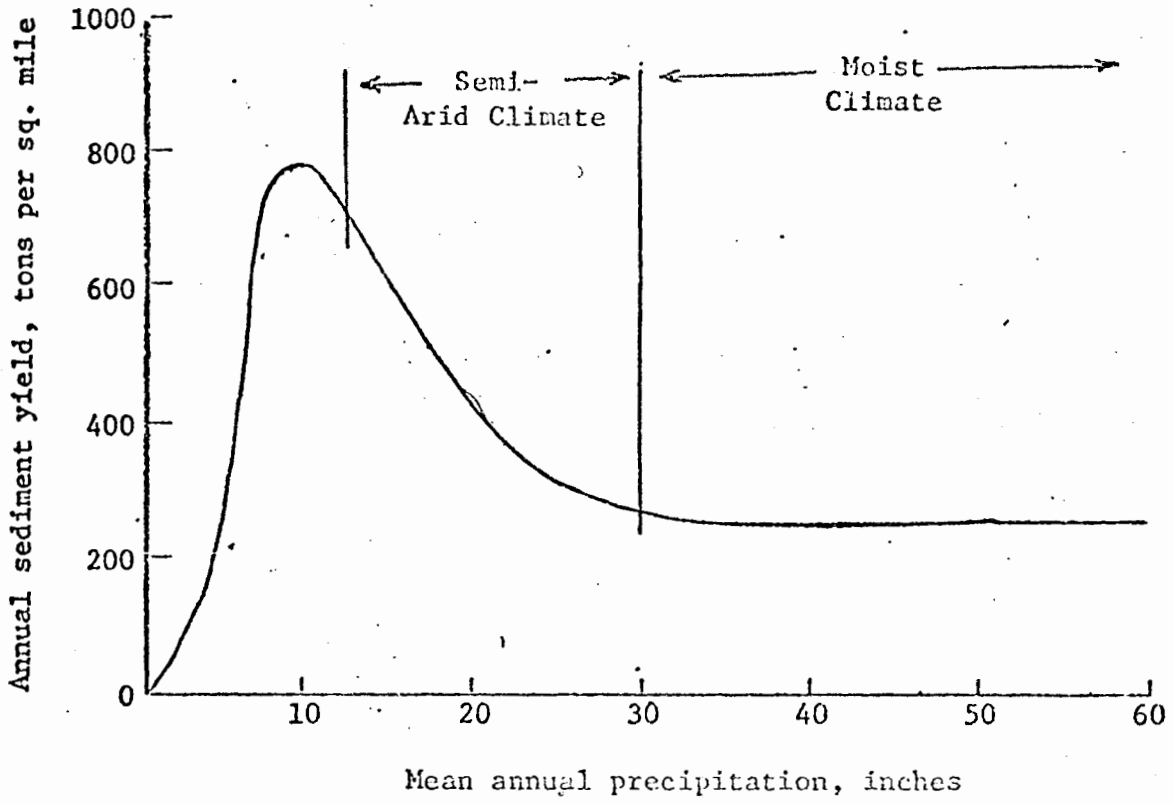

Figure 1. In climates sufficiently wet to grow forests, erosion tends to decrease with increasing precipitation, a seeming anomaly. Erosion is more directly correlated with vigor and density of forest vegetation, both of which tend to increase with increasing precipitation. Moisture is scarce in semi-arid climates, often occurring as snow or winter rain with virtually rainless summers. Often it is insufficient to support a dense and vigorous forest vegetation. Note that erosion rates decrease by about half as rain increases from 15 to 30 inches per year. Precipitation in moist climates may occur as rain or snow and tends to be evenly distributed throughout the year. Note that erosion rate holds almost constant when rain is over 30 inches per year. Most forests east of the 100th meridian are sufficiently dense and vigorous to qualify as moist climate vegetation. So are most forests of the Pacific Coast, interior Alaska, and those growing at highest elevations throughout the Western United States.

Erosion caused by wood products harvest

Although the distinction seems academic, it is useful to separate effects on soil erosion caused by cutting trees from effects caused by the harvest of timber products. On land sloping less than 35 degrees there is no evidence that tree cutting--even clearcutting--accelerates soil erosion much above geologic rates. Tree cutting does not significantly compact the forest soil, and it actually adds to the litter cover. In moist climates, natural revegetation ordinarily is so rapid and prolific, that a complete shrub and small-tree cover regrows within 2 or 3 years. Seeding or tree planting may be needed to revegetate cutover land adequately in semi-arid climates. On land sloping more than 35 degrees, tree cutting can lead to various forms of landsliding that severely accelerate soil erosion rates. This situation is easily dealt with by not harvesting wood products from unstable slopes or by cutting only a few trees at a time.

Timber harvesting--logging--is another matter. Dragging wood products directly across the forest floor disrupts its protective surface cover, exposing and compacting the underlying mineral soil so that overland flow can occur. The resulting erosion is most damaging on steep slopes and wet soils. Where soils are neither steep, wet, nor near streams, soil erosion is negligibly increased by dragging logs. The annual litter fall, soil freezing and thawing, and vegetative regrowth usually combine to restore hydrologic performance to precutting conditions within a year or two after logging in moist climate forests. Return to precutting conditions often takes much longer in forests in semi-arid climates. Cables, ballons, or helicopters may be used to minimize erosion in all of these areas.

High erosion rates often occur on temporary access routes and skid trails, exposing and compacting as much as 15 percent of the soil surface or almost 1 of every 7 acres on harvest sites where trucks and rubber-tired skidders are used. Skid trail erosion has no relation to selection cutting or clearcutting, indeed sometimes such erosion is most severe during selection cutting because of more frequent use of roads. Methods of logging and access route management that hold soil losses close to geological rates are simple and well known:

1. Do not log in streams.
2. Build the least temporary access routes and skid trails possible, avoiding steep and unstable slopes.
3. Locate access as far as practicable from streams.
4. Design all access routes carefully.
5. Apply erosion-control measures as needed.
6. Revegetate all temporary access routes as soon as possible.

Most soil-erosion problems relating to temporary access arise when these rules are not conscientiously applied, often because loggers perceive little need to minimize soil losses. Professional engineering reduces these problems on Forest Service system roads but improved capabilities are needed for quantifying road sediment losses under diverse conditions.

Nutrient losses caused by wood products harvest

Rather good estimates of nutrient losses incurred by removal of wood products from intensively managed forest were available from Europe before 1900. These results and their implications, well known to early American foresters, have been borne out and refined in modern studies.

Wood products harvest necessarily removes nutrients from the tree growing site. Nitrogen and mineral content of bark and wood is greater in hardwood than in conifers, is least in pine (Table 1). Losses of each nutrient are about proportional to the amount of wood harvested, with largest losses associated with fastest growing hardwood trees on the most fertile soils. Actual removal of nutrients in conventional harvest of conifer wood and bark usually is within the range of 1 to 10 kg./ha./yr. for the major elements. The following tabulation provides an approximate comparison of the annual balances for some major nutrients in hardwood stands. Similar data are available for coniferous stands but their biomass usually retains lesser amounts of nutrients than do hardwoods.

Annual nutrient disposition	Nutrient elements				
	N	P	K	Ca	Mg
	kg./ha./yr.				
Input into the forest soil 1/	55	4	33	113	23
Retention in the tree biomass 2/	30	2	16	74	6

1/ From North Carolina

2/ From Belgium

Adapted from "Forest management and nutrient cycling in eastern hardwoods" by James H. Patric and David W. Smith. USDA Forest Service Research Paper NE-324., Upper Darby, Pa. 12pp. illus.

Sources of nutrient inputs in the above tabulation include rainfall, canopy drip, streamflow, and litter fall; they do not include the low level of nitrogen fixation characteristic of the forest or the constantly on-going process of mineral weathering. The whole-earth rate of bedrock weathering is estimated at 270 kg./ha./yr., with weathering in New Hamphsire estimated to release 4 kg./ha./yr. of potassium and 8 of magnesium. Nutrient losses occasioned by conventional wood products harvest appear to be well within the replacement rates of most forest soils, even apart from atmospheric replacement.

Table 1. Estimated quantities of mineral nutrients removed in all stemwood and bark by intensive thinning plus clearcutting the main crop at 100 years. (From a compilation of older European data).

Kind of tree	Nutrient (kg./ha./yr.)		
	CA	K	P
Pines	279	104	20
Other conifers	566	277	39
Hardwoods	1,434	326	64

Adapted from reference 11.

There also is great concern that heavy cutting, particularly clear-cutting, will accelerate leaching of soil nutrients from forest land. The heaviest such leaching reported, nitrogen and calcium amounting to 2 and 4% respectively of the total amounts in a podzol soil, occurred 2 years after conventional clearcutting in New Hampshire. Losses of this magnitude have not been reported elsewhere, regardless of harvest methods used. These losses too are replaceable by weathering and atmospheric inputs long before the new tree generation has regrown (see reference 11). In moist climates, the new generation of small trees, after perhaps 3 years of regrowth, seems as capable as former mature stands of forestalling accelerated rates of leaching from cutover land. Recovery rates probably are less rapid in the semi-arid climates.

An alternative interpretation of the well-conducted research at the Hubbard Brook Experimental Forest in New Hampshire may be useful for those who are deeply concerned with the spectre of accelerated nutrient leaching. Results from these studies first appeared when public criticism of clearcutting was arising; the results from Hubbard Brook were and continued to be used to support such criticism. But the treatment used was not clearcutting, it was deforestation. All vegetation was cut and allowed to decay on a 39-acre watershed. Reproduction was sprayed with herbicide for 3 years to prevent regrowth. An accelerated outflow of soil nutrients accompanied this treatment but the outflow returned to essentially pre-cutting conditions about 2 years after regrowth was permitted. The Hubbard Brook results frequently are understood as evidencing that soil sterility threatens to follow any but the most conservative forest cutting.

Too little is made of far more useful implications of the Hubbard Brook study. By cutting the forest and preventing regrowth, we gained, for the first time, some insight into the enormous amount of nutrients available to a new generation of forest trees. The cutting and herbicide treatment was, in effect, a planned disaster. Consider the events that followed--greater soil moisture, increased soil temperature, better aeration, and increased chemical and biological activity in the freshly exposed forest floor. Fallen trees and foliage decomposed to augment nutrients also being released from decaying litter. Given normal forest conditions, these events would provide optimal nutrition for seedling and sprout growth. But preventing regrowth with herbicides prevented all nutrient uptake and some of these decay-released materials were lost from the ecosystem via streamflow.

We interpret these results as evidence, not of damaging loss of soil fertility accompanying timber harvest, but of a survival mechanism to assure vigorous regrowth after disaster, whether man-caused or natural. When a pioneer stand finally was allowed to develop at Hubbard Brook, substantial loss of soil fertility ceased and nutrients were stored in pin cherry for subsequent use by the more permanent stand that followed. This experiment thus demonstrates a "shot-in-the-arm" effect following disaster, in which massive nutrient releases probably stimulate reforestation. Lesser nutrient releases probably stimulate regrowth similarly on land under more conventional forest management.

Tree limbs and roots remaining on-site after conventional wood products harvest provide important sources of nutrients for regenerating cutover stands. Whole-tree harvesting for pulpwood may utilize both of these nutrient sources; it is coming into vogue, and stands so managed must be watched closely for symptoms of nutrient deficiency. Should reduced tree growth or other nutrient problems develop, most of them are curable by modified cutting practices. A few are curable by fertilization, although this practice is known to increase chemical loading in streams. In view of its increasing cost and of worldwide food and energy shortages, forest fertilization may never be practiced widely.

Over-grazing, careless logging, and heavy recreation often disrupt the protective surface cover, thereby exposing the underlying mineral soil to erosive action by rainfall. In addition, such forest misuses compact the mineral soil, greatly reducing infiltration rates. Soil exposure and compaction always lead to or worsen overland flow and accelerated erosion.

Severe fires expose large expanses of soil to erosion, although such fires are rare in moist climates. Research to date suggests that controlled burning increases erosion somewhat over geological rates, but the accelerated rates seldom persist for more than a few years. Burning does, even under control, alter forest composition. More research is needed to understand the full role of fire, but it is increasingly clear that most burning in moist climate forests has little effect on amounts of soil loss. Wildfire can enormously increase erosion rates in semi-arid regions.

Effects on Water

Given about 45 inches of precipitation annually on mature forest, perhaps 5 to 15 inches never reached the soil: it is intercepted on foliage, branches, and litter, then evaporated from these wetted surfaces. Of rain that does enter the soil, perhaps 15 inches is subsequently lost by transpiration, the evaporation of soil moisture through the foliage. Some infiltrated water seeps into bedrock, but the balance ordinarily becomes streamflow. Thus streamflow is the remainder from precipitation after all other losses of water have occurred. The actual amounts in this water-balance vary from place to place, but the principles apply universally.

Streamflow=

When the moist climate forest is cut, both the interception and transpiration losses decrease. The Conservation-of-Mass Law applies; and, as these evaporative losses decrease, streamflow increases accordingly. But evaporation never is eliminated, so streamflow never increases to the full amount of evaporative demand. Streamflow increases are proportional to the severity of forest cutting; and clearcutting causes maximum first-year increases, ranging from 6 to 18 inches. Streamflow always decreases as regrowing forests return evaporative losses to before-cutting levels, a process that may require only 1 year after partial cutting to more than 10 years after clearcutting. First-year streamflow increases ranging from 0-6 inches are all that can be expected 1 year after clearcutting in the semi-arid climates, although these lesser increases often persist longer because of less vigorous vegetative regrowth.

Flow increases, though measurable on tiny headwater streams, are seldom detectable when the far greater volumes of flow in large rivers are measured. There, the flow-increasing effects of cutting in some places usually are counteracted by the flow-decreasing effects of regrowth in other places. Forest cutting, blowdown, or fire of regional extent must occur before evaporative losses are sufficiently reduced to cause measurable flow increases in major rivers.

It is clear that the largest flow increases should be realized by cutting those trees that evaporate most water. It now seems that permanently foliaged conifers intercept as well as transpire more water than do deciduous hardwoods, while grass uses less than either kind of tree. To date, research has not shown, in moist climates, that annual water use varies significantly among species of conifer or of hardwood or with the size and age of the trees. As used here, trees refers to vegetation larger than saplings. The field of plant-water relations remains one of great and continuing research interest because here, too, complete answers are not yet available.

Autumn marks the end of significant transpiration from the temperate zone and boreal forest, the beginning of soil-moisture replacement after the growing season. After late autumn, soil water in moist climates returns to near-capacity levels, and most of the subsequent [illegible] rain moves quickly through the soil to streams. Under these dormant [illegible]

conditions, there is little difference in stream behavior on tree-covered or treeless forest land--if the soil surface cover is intact, if the lying soil is uncompacted and unfrozen, and if all water moves through, not across the land surface. This generalization holds true only if rain is adequate to recharge soil moisture depleted during the preceding growing season. Low flows characteristic of the growing season often persist far into dormant seasons when winter rain is deficient in semi-arid climates.

With resumption of growth in the spring, soil-plant-water relations are much changed. Rainfall interception may or may not change but transpiration greatly increases, with correspondingly decreased soil moisture. Under these typical growing-season conditions, most of the rain that enters the soil serves merely to replace previous losses to transpiration. Unless rain is very heavy, most of it is stored in the soil, and little of it can reach a stream; so the low flows prevail that are characteristic of the growing season.

On cutover land the evaporative losses causing soil-moisture depletion are minimal. Most of the rain that falls still enters the soil, but whatever soil moisture has been evaporated is quickly replaced; and absorbed rain moves rapidly through the soil to streams. With clearcutting or other substantial vegetation removal, growing-season flow is thereby augmented with rain diverted from evaporative loss. Thus, growing-season flows are much increased by heavy tree cutting, but dormant season flow is virtually unaffected--in moist climates.

The forest-flood relationship merits special attention. In their zeal to achieve the proven ability of forests to control soil erosion, foresters of several decades ago were to proclaim corollary, sometimes unfounded, flood-control benefits. A more realistic view of the forest role in flooding is now possible in moist climates after many years of carefully replicated research at several installations.

Dormant-season floods usually are caused by extensive frontal storms, and sometimes they are augmented when rain falls on melting snow. For reasons already stated, presence or absence of trees has little effect on delivery of dormant-season stormflow to streams. Overland flow from eroding logging roads conceivably augments stormflow; but, common as such roads are, they nevertheless are too few and scattered to aggravate flooding on a regional scale. The inescapable conclusion is that heavy rains cause floods, regardless of the condition of the tree cover.

Conceivably, regionwide heavy cutting could increase forest soil moisture enough to augment flooding during the growing season. Several factors serve to mitigate this possibility. In the East, the prevailing pattern of small ownership, coupled with the enormous diversity of forest conditions, precludes regionwide cutting. Except in the Pacific Northwest, frontal storms are not common in the growing season; high-intensity thunder storms produce most of the summer rainfall and sometimes cause local flash flooding. But even if the locations of high-intensity summer showers did happen to coincide with patches of heavy cutting, the resulting stormflow in headwater streams would soon be contained in the larger unflooded channels downstream. When great regional storms do occur in the growing season (for example, the tropical hurricanes), heavy rain fills even the forested soils to capacity, and thereafter stormflow from all forest land resembles that of the dormant season; and tree-covered and cutover lands behave similarly. There is little reason to believe that forest cutting can increase the frequency or severity of flooding, except under conditions of virtual regional deforestation.

Despite the preceeding interpretations of research, there are records of increased flooding after destruction of the eastern old-growth forest some 75 to 100 years ago. But this was regionwide cutting, followed--more importantly--by wildfire, overgrazing, and steep land agriculture that prevented much natural regrowth of trees. Some of the affected areas have not regrown trees to this day. The all important point is that regional and lasting deforestation, not timber harvesting, somewhat increased the turn-of-the-century flood hazard.

Management of snow offers some real possibilities to augment water resources at higher elevation in Western United States. Water yields may be increased or decreased, depending on how the indigenous coniferous vegetation is cut. Judicious clearcutting in patches or in strips can provide 2 to 6 inches more of streamflow per year. Properly located snow fencing can prolong snowmelt, thus decreasing the spring freshet runoff and prolonging streamflow into the summer. As for a distantly related finding, it recently was concluded that forest management in the Northeast need not be considered as a means of protection from snowmelt flooding.

The quality of water in forest streams, touched upon previously, is strongly influenced by its routing from atmosphere to channel. Two kinds of materials, particulate matter and dissolved solids, primarily determine the quality of water. Lack of overland flow limits the occurrence of particulate matter in streams of the moist climate region. Non-storm flows ordinarily run essentially clear, although flows augmented by tree cutting can be slightly turbid because of particulate matter scoured from channels. Stormflows can become much more turbid when their greater volume and velocity detach much more particulate matter from channels. Nevertheless, there is no overland flow and therefore no mechanism to detach or transport particulate matter across the forest floor. Overland flow does occur on some forested land in semi-arid regions and is a factor contributing to greater sediment loads characterizing streams of those regions.

There is a curious dichotomy of opinion concerning dissolved solids in forest streams. Biologists know that some increase in their nutrient content often is beneficial to the aquatic habitat. Productivity of many headwater streams is limited by nutrient deficiency. Yet those who criticize forest cutting often choose to regard any change from pristine conditions as undesirable. Perhaps this matter never can be resolved to everyone's satisfaction but it seems certain that some increase in dissolved solids content of headwater streams offers potential benefits to the biota with minimal risk to other water values.

Stream temperature increases when shading vegetation is removed from channels. Solar heating may range from 0 to 10 degrees above temperatures experienced before cutting, the increase depending on topography, latitude, season, and stream dimensions. Here too a dichotomy of opinion prevails. Increased temperature is regarded as thermal pollution by the critics of forest cutting. There is, however, a valid basis for arguing that aquatic biota can benefit from heat added to very cold streams. Water is best kept cool by preserving the shading vegetation and these shade strips need not be especially wide.

Ordinarily, only a bland sufficiently wide to fully shade the channel is all that is needed to maintain cool water during and after forest cutting, even clearcutting.

Conclusions

1. There is little evidence that conventional wood products harvest--including clearcutting--will deplete nutrient levels in most forest soils. Depletion following greater wood utilization on shorter rotations is possible and must be guarded against carefully.

2. Soil erosion rates can be accelerated unacceptably during poorly regulated logging, regardless of the silvicultural system used. Soil erosion usually can be held to acceptable levels by intelligent regulation of logging practices.

3. A number of forest cutting practices are known that increase the low flows typical of forest streams in late summer. This cutting usually has little adverse effect on water quality or on regional flooding. Flow increases tend to be least in dry climates while the adverse effects on water quality may be greater than those characteristic of the moist climate forests.

Suggested references for further information

1. American Society of Civil Engineers. 1975. "Watershed Management." Proceedings of a Symposium conducted by the Irrigation and Drainage Division. 781 p., illus. ASCE, 345 East 47th Street, New York.

2. Csallang, Sandor C., et al., editors. 1972. "Watersheds in Transition." Proceedings of a Symposium conducted by the American Water Resources Association. 405 p., illus. AWRA, 206 East University Ave., Urbana, Illinois.

3. Douglass, James E. 1975. "Southeastern forests and the problem of nonpoint sources of water pollution." In "Non-point sources of water pollution." Peter M. Ashton and Richard C. Underwood, editors. 314 p., illus. Virginia Water Resources Center, Blacksburg, Va.

4. Leaf, Charles C. 1975. "Watershed management in the central and southern Rocky Mountains: a summary of the status of our knowledge by vegetation types." USDA Forest Service Research Paper RM-142. 28p., illus. Fort Collins, Colorado.

5. Lull, Howard W., and Kenneth G. Reinhart. 1972. "Forests and floods in the eastern United States." USDA Forest Service Research Paper NE-226. 94p. Upper Darby, Pa.

6. Patric, James H. 1976. "Soil erosion in the eastern hardwood forest." Accepted for publication by the Journal of Forestry.

7. Rothacker, Jack. 1971. "Regimes of streamflow and their modification by logging." Pages 40-54 In Proceedings of a Symposium on Forest Land Uses and Stream Environment. School of Forestry, Oregon State University, Corvallis, Oregon.

8. Satterlund, Donald R. 1972. "Wildland Watershed Management." 370 p., illus. The Ronald Press Co., New York.

9. Sopper, William E., and Edward S. Corbett, Symposium co-chairmen. 1975. "Municipal Watershed Management." USDA Forest Service General Technical Report NE-13. 196 p., illus. Upper Darby, Pa.

10. Sopper, William E., and Howard W. Lull, editors. 1967. "International Symposium on Forest Hydrology." 812 p., illus. Pergamon Press, New York.

11. Stone, Earl. 1973. "The impact of timber harvest on soils and water." Page 427 in "Report of the President's Advisory Panel on Timber and the Environment," 541 p., illus. U.S. Gov't. Printing Office, Washington, D.C.

12. Swanston, D.N. 1974. "Slope stability problems associated with timber harvesting in mountainous regions of the United States." 14 p., illus. USDA Forest Service General Technical Report PNW-21. Portland, Oregon.

Effects of Wood Products Harvest on Forest, Soil and Water Resources, With Emphasis on Clearcutting in Moist Climates

James H. Patric[1/]

Introduction

Nowhere in the World is there a firmer factual record of how forestry practices affect soil and water than is available for the United States. Forest Service research has led in most of these investigations, but other Federal and State agencies as well as the universities have contributed important new knowledge. Forest Service research concerning forest influences on water resources began about 1910 in the American Southwest, about 25 years later in the Southeast. By 1965, no region in the United States having significant forest resources was without Forest Service and university research programs designed to show both good and bad effects of man's uses of the forest on soil and water resources. A pattern of relatively consistent results has emerged from this accumulation of information.

Effects on Soil

Erosion before wood products harvest

Soils are well protected from erosion by dense strands of mature trees, but even under these conditions some loss does occur. Erosion is a normal geologic process even in uncut forests, most active where annual precipitation ranges from 15 to 30 inches per year (Figure 1). Forest vegetation tends to be scanty and develops slowly in these semi-arid climates. With increasing moisture, vegetation tends to increase in density and vigor. When annual precipitation exceeds 30 inches, soil erosion rates are not further reduced nor do they increase when annual precipitation far exceeds 30 inches. With increasing precipitation more water is available to erode soils, but losses remain at a relatively constant level because vegetation grows most vigorously and densely in wettest regions.

Some generalizations are possible concerning measurements of soil loss in moist climates regions that include much of the forest land in the United States, and most of the commercial timber producing land. Erosion rates up to 0.1 ton per acre per year must be accepted, even in the old-growth forest. This may be considered the geologic norm for moist climate forest and it probably varies from less than 0.05 ton to 0.3 ton per acre per year, depending on geology, soil, climate, and vegetation. Although tons per acre implies a uniform sheet erosion, soil lost from undisturbed forest in moist climates almost always originates in stream channels. Similar generalizations are not possible concerning the geologic norms of semi-arid climate forest except that erosion rates there are always higher.

The key to holding soil loss close to the geologic norm in moist climates is to avoid disturbing the soil and vegetation close to stream channels. The kind, size, or density of trees has little influence on soil erodibility, as long as the forest soil structure

---

James H. Patric, Northeastern Forest Experiment Station, Timber and Watershed Laboratory, Parsons, West Virginia.

remains relatively undisturbed. Forest soil is virtually armored against erosion by surface accumulations of fresh as well as decomposing leaves and twigs, ranging from three or more tons per acre in southern latitudes of the moist climate region to 12 or more tons per acre in the North. The organic cover is replenished annually by litter fall at rates from 1 or 2 tons per acre. But tree cover may be too sparse in drier regions to produce nearly this much litter. There, the litter cover may be interspersed with grass or even a stony soil surface.

The soil surface cover is the key to minimizing erosion on nonchannel portions of forest watersheds. Litter, minor vegetation, and stones absorb the entire kinetic energy of falling rain, thus preventing compaction and sealing of the surface soil which usually occurs when rain beats down on soil unprotected by a surface cover. Furthermore, water infiltrates rapidly when deep and permeable soil lies beneath this cover, at rates far exceeding rainfall intensity. Infiltration rates of 50 or more inches per hour are common in moist climates while rainfall intensities of more than 2 inches per hour are uncommon. For the simple physical reason that rain almost always is absorbed into moist climate soil faster than it falls, most forest hydrologists hold that surface runoff or overland flow rarely occurs in these regions. Lacking overland flow, there is no mechanism to detach soil particles or to transport them across the forest floor. Only the stream channels, unprotected by litter, always provide sites for active soil erosion in the undisturbed forest. Infiltration rates sometimes are lower in semi-arid climates and overland flow is more common.

But water storage capacity of the soil profile, particularly in wet weather, often is insufficient to contain all of the infiltrated rain. Under these circumstances, the absorbed rain moves laterally through the soil to streams. Forest hydrologists generally agree, where there is adequate surface cover on deep and permeable soil, that complete absorption of precipitation and its subsequent movement through the soil accounts for most forest streamflow, during as well as between storms.

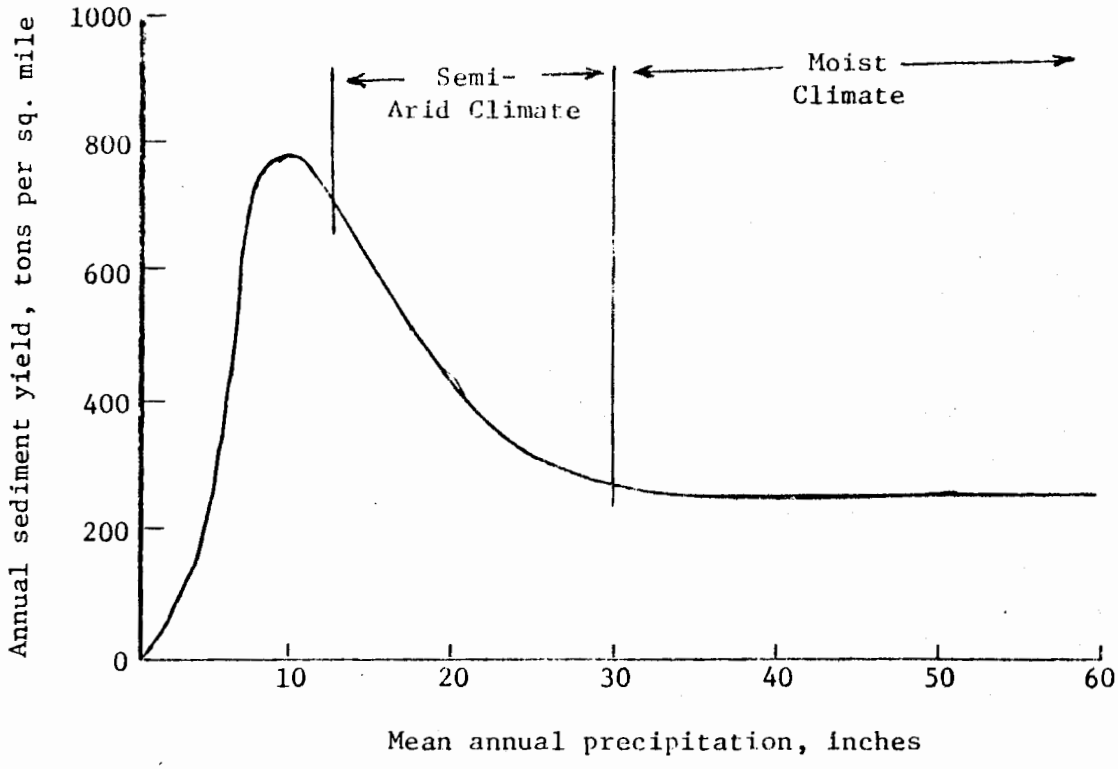

Figure 1. In climates sufficiently wet to grow forests, erosion tends to decrease with increasing precipitation, a seeming anomaly. Erosion is more directly correlated with vigor and density of forest vegetation, both of which tend to increase with increasing precipitation. Moisture is scarce in semi-arid climates, often occurring as snow or winter rain with virtually rainless summers. Often it is insufficient to support a dense and vigorous forest vegetation. Note that erosion rates decrease by about half as rain increases from 15 to 30 inches per year. Precipitation in moist climates may occur as rain or snow and tends to be evenly distributed throughout the year. Note that erosion rate holds almost constant when rain is over 30 inches per year. Most forests east of the 100th meridian are sufficiently dense and vigorous to qualify as moist climate vegetation. So are most forests of the Pacific Coast, interior Alaska, and those growing at highest elevations throughout the Western United States.

Erosion caused by wood products harvest

Although the distinction seems academic, it is useful to separate effects on soil erosion caused by cutting trees from effects caused by the harvest of timber products. On land sloping less than 35 degrees there is no evidence that tree cutting--even clearcutting--accelerates soil erosion much above geologic rates. Tree cutting does not significantly compact the forest soil, and it actually adds to the litter cover. In moist climates, natural revegetation ordinarily is so rapid and prolific, that a complete shrub and small-tree cover regrows within 2 or 3 years. Seeding or tree planting may be needed to revegetate cutover land adequately in semi-arid climates. On land sloping more than 35 degrees, tree cutting can lead to various forms of landsliding that severely accelerate soil erosion rates. This situation is easily dealt with by not harvesting wood products from unstable slopes or by cutting only a few trees at a time.

Timber harvesting--logging--is another matter. Dragging wood products directly across the forest floor disrupts its protective surface cover, exposing and compacting the underlying mineral soil so that overland flow can occur. The resulting erosion is most damaging on steep slopes and wet soils. Where soils are neither steep, wet, nor near streams, soil erosion is negligibly increased by dragging logs. The annual litter fall, soil freezing and thawing, and vegetative regrowth usually combine to restore hydrologic performance to precutting conditions within a year or two after logging in moist climate forests. Return to precutting conditions often takes much longer in forests in semi-arid climates. Cables, ballons, or helicopters may be used to minimize erosion in all of these areas.

High erosion rates often occur on temporary access routes and skid trails, exposing and compacting as much as 15 percent of the soil surface or almost 1 of every 7 acres on harvest sites where trucks and rubber-tired skidders are used. Skid trail erosion has no relation to selection cutting or clearcutting, indeed sometimes such erosion is most severe during selection cutting because of more frequent use of roads. Methods of logging and access route management that hold soil losses close to geological rates are simple and well known:

1. Do not log in streams.

2. Build the least temporary access routes and skid trails possible, avoiding steep and unstable slopes.

3. Locate access as far as practicable from streams.

4. Design all access routes carefully.

5. Apply erosion-control measures as needed.

6. Revegetate all temporary access routes as soon as possible.

Most soil-erosion problems relating to temporary access arise when these rules are not conscientiously applied, often because loggers perceive little need to minimize soil losses. Professional engineering reduces these problems on Forest Service system roads but improved capabilities are needed for quantifying road sediment losses under diverse conditions.

Nutrient losses caused by wood products harvest

Rather good estimates of nutrient losses incurred by removal of wood products from intensively managed forest were available from Europe before 1900. These results and their implications, well known to early American foresters, have been borne out and refined in modern studies.

Wood products harvest necessarily removes nutrients from the tree growing site. Nitrogen and mineral content of bark and wood is greater in hardwood than in conifers, is least in pine (Table 1). Losses of each nutrient are about proportional to the amount of wood harvested, with largest losses associated with fastest growing hardwood trees on the most fertile soils. Actual removal of nutrients in conventional harvest of conifer wood and bark usually is within the range of 1 to 10 kg./ha./yr. for the major elements. The following tabulation provides an approximate comparison of the annual balances for some major nutrients in hardwood stands. Similar data are available for coniferous stands but their biomass usually retains lesser amounts of nutrients than do hardwoods.

Annual nutrient disposition	Nutrient elements				
	N	P	K	Ca	Mg
	kg./ha./yr.				
Input into the forest soil 1/	55	4	33	113	23
Retention in the tree biomass 2/	30	2	16	74	6

1/ From North Carolina

2/ From Belgium

Adapted from "Forest management and nutrient cycling in eastern hardwoods" by James H. Patric and David W. Smith. USDA Forest Service Research Paper NE-324., Upper Darby, Pa. 12pp. illus.

Sources of nutrient inputs in the above tabulation include rainfall, canopy drip, streamflow, and litter fall; they do not include the low level of nitrogen fixation characteristic of the forest or the constantly on-going process of mineral weathering. The whole-earth rate of bedrock weathering is estimated at 270 kg./ha./yr., with weathering in New Hamphsire estimated to release 4 kg./ha./yr. of potassium and 8 of magnesium. Nutrient losses occasioned by conventional wood products harvest appear to be well within the replacement rates of most forest soils, even apart from atmospheric replacement.

Table 1. Estimated quantities of mineral nutrients removed in all stemwood and bark by intensive thinning plus clearcutting the main crop at 100 years. (From a compilation of older European data).

Kind of tree	Nutrient (kg./ha./yr.)		
	CA	K	P
Pines	279	104	20
Other conifers	566	277	39
Hardwoods	1,434	326	64

Adapted from reference 11.

There also is great concern that heavy cutting, particularly clearcutting, will accelerate leaching of soil nutrients from forest land. The heaviest such leaching reported, nitrogen and calcium amounting to 2 and 4% respectively of the total amounts in a podzol soil, occurred 2 years after conventional clearcutting in New Hampshire. Losses of this magnitude have not been reported elsewhere, regardless of harvest methods used. These losses too are replaceable by weathering and atmospheric inputs long before the new tree generation has regrown (see reference 11). In moist climates, the new generation of small trees, after perhaps 3 years of regrowth, seems as capable as former mature stands of forestalling accelerated rates of leaching from cutover land. Recovery rates probably are less rapid in the semi-arid climates.

An alternative interpretation of the well-conducted research at the Hubbard Brook Experimental Forest in New Hampshire may be useful for those who are deeply concerned with the spectre of accelerated nutrient leaching. Results from these studies first appeared when public criticism of clearcutting was arising; the results from Hubbard Brook were and continued to be used to support such criticism. But the treatment used was not clearcutting, it was deforestation. All vegetation was cut and allowed to decay on a 39-acre watershed. Reproduction was sprayed with herbicide for 3 years to prevent regrowth. An accelerated outflow of soil nutrients accompanied this treatment but the outflow returned to essentially pre-cutting conditions about 2 years after regrowth was permitted. The Hubbard Brook results frequently are understood as evidencing that soil sterility threatens to follow any but the most conservative forest cutting.

Too little is made of far more useful implications of the Hubbard Brook study. By cutting the forest and preventing regrowth, we gained, for the first time, some insight into the enormous amount of nutrients available to a new generation of forest trees. The cutting and herbicide treatment was, in effect, a planned disaster. Consider the events that followed--greater soil moisture, increased soil temperature, better aeration, and increased chemical and biological activity in the freshly exposed forest floor. Fallen trees and foliage decomposed to augment nutrients also being released from decaying litter. Given normal forest conditions, these events would provide optimal nutrition for seedling and sprout growth. But preventing regrowth with herbicides prevented all nutrient uptake and some of these decay-released materials were lost from the ecosystem via streamflow.

We interpret these results as evidence, not of damaging loss of soil fertility accompanying timber harvest, but of a survival mechanism to assure vigorous regrowth after disaster, whether man-caused or natural. When a pioneer stand finally was allowed to develop at Hubbard Brook, substantial loss of soil fertility ceased and nutrients were stored in pin cherry for subsequent use by the more permanent stand that followed. This experiment thus demonstrates a "shot-in-the-arm" effect following disaster, in which massive nutrient releases probably stimulate reforestation. Lesser nutrient releases probably stimulate regrowth similarly on land under more conventional forest management.

Tree limbs and roots remaining on-site after conventional wood products harvest provide important sources of nutrients for regenerating cutover stands. Whole-tree harvesting for pulpwood may utilize both of these nutrient sources; it is coming into vogue, and stands so managed must be watched closely for symptoms of nutrient deficiency. Should reduced tree growth or other nutrient problems develop, most of them are curable by modified cutting practices. A few are curable by fertilization, although this practice is known to increase chemical loading in streams. In view of its increasing cost and of worldwide food and energy shortages, forest fertilization may never be practiced widely.

Over-grazing, careless logging, and heavy recreation often disrupt the protective surface cover, thereby exposing the underlying mineral soil to erosive action by rainfall. In addition, such forest misuses compact the mineral soil, greatly reducing infiltration rates. Soil exposure and compaction always lead to or worsen overland flow and accelerated erosion.

Severe fires expose large expanses of soil to erosion, although such fires are rare in moist climates. Research to date suggests that controlled burning increases erosion somewhat over geological rates, but the accelerated rates seldom persist for more than a few years. Burning does, even under control, alter forest composition. More research is needed to understand the full role of fire, but it is increasingly clear that most burning in moist climate forests has little effect on amounts of soil loss. Wildfire can enormously increase erosion rates in semi-arid regions.

Effects on Water

Given about 45 inches of precipitation annually on mature forest, perhaps 5 to 15 inches never reached the soil: it is intercepted on foliage, branches, and litter, then evaporated from these wetted surfaces. Of rain that does enter the soil, perhaps 15 inches is subsequently lost by transpiration, the evaporation of soil moisture through the foliage. Some infiltrated water seeps into bedrock, but the balance ordinarily becomes streamflow. Thus streamflow is the remainder from precipitation after all other losses of water have occurred. The actual amounts in this water-balance vary from place to place, but the principles apply universally.

When the moist climate forest is cut, both the interception and transpiration losses decrease. The Conservation-of-Mass Law applies; and, as these evaporative losses decrease, streamflow increases accordingly. But evaporation never is eliminated, so streamflow never increases to the full amount of evaporative demand. Streamflow increases are proportional to the severity of forest cutting; and clearcutting causes maximum first-year increases, ranging from 6 to 18 inches. Streamflow always decreases as regrowing forests return evaporative losses to before-cutting levels, a process that may require only 1 year after partial cutting to more than 10 years after clearcutting. First-year streamflow increases ranging from 0-6 inches are all that can be expected 1 year after clearcutting in the semi-arid climates, although these lesser increases often persist longer because of less vigorous vegetative regrowth.

Flow increases, though measurable on tiny headwater streams, are seldom detectable when the far greater volumes of flow in large rivers are measured. There, the flow-increasing effects of cutting in some places usually are counteracted by the flow-decreasing effects of regrowth in other places. Forest cutting, blowdown, or fire of regional extent must occur before evaporative losses are sufficiently reduced to cause measurable flow increases in major rivers.

It is clear that the largest flow increases should be realized by cutting those trees that evaporate most water. It now seems that permanently foliaged conifers intercept as well as transpire more water than do deciduous hardwoods, while grass uses less than either kind of tree. To date, research has not shown, in moist climates, that annual water use varies significantly among species of conifer or of hardwood or with the size and age of the trees. As used here, trees refers to vegetation larger than saplings. The field of plant-water relations remains one of great and continuing research interest because here, too, complete answers are not yet available.

Autumn marks the end of significant transpiration from the temperate zone and boreal forest, the beginning of soil-moisture replacement after the growing season. After late autumn, soil water in moist climates returns to near-capacity levels, and most of the subsequently absorbed rain moves quickly through the soil to streams. Under these dormant-season

conditions, there is little difference in stream behavior on tree-covered or treeless forest land-- if the soil surface cover is intact, if the lying soil is uncompacted and unfrozen, and if all water moves through, not across the land surface. This generalization holds true only if rain is adequate to recharge soil moisture depleted during the preceding growing season. Low flows characteristic of the growing season often persist far into dormant seasons when winter rain is deficient in semi-arid climates.

With resumption of growth in the spring, soil-plant-water relations are much changed. Rainfall interception may or may not change but transpiration greatly increases, with correspondingly decreased soil moisture. Under these typical growing-season conditions, most of the rain that enters the soil serves merely to replace previous losses to transpiration. Unless rain is very heavy, most of it is stored in the soil, and little of it can reach a stream; so the low flows prevail that are characteristic of the growing season.

On cutover land the evaporative losses causing soil-moisture depletion are minimal. Most of the rain that falls still enters the soil, but whatever soil moisture has been evaporated is quickly replaced; and absorbed rain moves rapidly through the soil to streams. With clearcutting or other substantial vegetation removal, growing-season flow is thereby augmented with rain diverted from evaporative loss. Thus, growing-season flows are much increased by heavy tree cutting, but dormant season flow is virtually unaffected--in moist climates.

The forest-flood relationship merits special attention. In their zeal to achieve the proven ability of forests to control soil erosion, foresters of several decades ago were to proclaim corollary, sometimes unfounded, flood-control benefits. A more realistic view of the forest role in flooding is now possible in moist climates after many years of carefully replicated research at several installations.

Dormant-season floods usually are caused by extensive frontal storms, and sometimes they are augmented when rain falls on melting snow. For reasons already stated, presence or absence of trees has little effect on delivery of dormant-season stormflow to streams. Overland flow from eroding logging roads conceivably augments stormflow; but, common as such roads are, they nevertheless are too few and scattered to aggravate flooding on a regional scale. The inescapable conclusion is that heavy rains cause floods, regardless of the condition of the tree cover.

Conceivably, regionwide heavy cutting could increase forest soil moisture enough to augment flooding during the growing season. Several factors serve to mitigate this possibility. In the East, the prevailing pattern of small ownership, coupled with the enormous diversity of forest conditions, precludes regionwide cutting. Except in the Pacific Northwest, frontal storms are not common in the growing season; high-intensity thunder storms produce most of the summer rainfall and sometimes cause local flash flooding. But even if the locations of high-intensity summer showers did happen to coincide with patches of heavy cutting, the resulting stormflow in headwater streams would soon be contained in the larger unflooded channels downstream. When great regional storms do occur in the growing season (for example, the tropical hurricanes), heavy rain fills even the forested soils to capacity, and thereafter stormflow from all forest land resembles that of the dormant season; and tree-covered and cutover lands behave similarly. There is little reason to believe that forest cutting can increase the frequency or severity of flooding, except under conditions of virtual regional deforestation.

Despite the preceeding interpretations of research, there are records of increased flooding after destruction of the eastern old-growth forest some 75 to 100 years ago. But this <u>was</u> regionwide cutting, followed--more importantly--by wildfire, overgrazing, and steep land agriculture that prevented much natural regrowth of trees. Some of the affected areas have not regrown trees to this day. The all important point is that regional and lasting deforestation, not timber harvesting, somewhat increased the turn-of-the-century flood hazard.

Management of snow offers some real possibilities to augment water resources at higher elevation in Western United States. Water yields may be increased or decreased, depending on how the indigenous coniferous vegetation is cut. Judicious clearcutting in patches or in strips can provide 2 to 6 inches more of streamflow per year. Properly located snow fencing can prolong snowmelt, thus decreasing the spring freshet runoff and prolonging streamflow into the summer. As for a distantly related finding, it recently was concluded that forest management in the Northeast need not be considered as a means of protection from snowmelt flooding.

The quality of water in forest streams, touched upon previously, is strongly influenced by its routing from atmosphere to channel. Two kinds of materials, particulate matter and dissolved solids, primarily determine the quality of water. Lack of overland flow limits the occurrence of particulate matter in streams of the moist climate region. Non-storm flows ordinarily run essentially clear, although flows augmented by tree cutting can be slightly turbid because of particulate matter scoured from channels. Stormflows can become much more turbid when their greater volume and velocity detach much more particulate matter from channels. Nevertheless, there is no overland flow and therefore no mechanism to detach or transport particulate matter across the forest floor. Overland flow does occur on some forested land in semi-arid regions and is a factor contributing to greater sediment loads characterizing streams of those regions.

There is a curious dichotomy of opinion concerning dissolved solids in forest streams. Biologists know that some increase in their nutrient content often is beneficial to the aquatic habitat. Productivity of many headwater streams is limited by nutrient deficiency. Yet those who criticize forest cutting often choose to regard any change from pristine conditions as undesirable. Perhaps this matter never can be resolved to everyone's satisfaction but it seems certain that some increase in dissolved solids content of headwater streams offers potential benefits to the biota with minimal risk to other water values.

Stream temperature increases when shading vegetation is removed from channels. Solar heating may range from 0 to 10 degrees above temperatures experienced before cutting, the increase depending on topography, latitude, season, and stream dimensions. Here too a dichotomy of opinion prevails. Increased temperature is regarded as thermal pollution by the critics of forest cutting. There is, however, a valid basis for arguing that aquatic biota can benefit from heat added to very cold streams. Water is best kept cool by preserving the shading vegetation and these shade strips need not be especially wide.

Ordinarily, only a bland sufficiently wide to fully shade the channel is all that is needed to maintain cool water during and after forest cutting, even clearcutting.

Conclusions

1. There is little evidence that conventional wood products harvest--including clearcutting--will deplete nutrient levels in most forest soils. Depletion following greater wood utilization on shorter rotations is possible and must be guarded against carefully.

2. Soil erosion rates can be accelerated unacceptably during poorly regulated logging, regardless of the silvicultural system used. Soil erosion usually can be held to acceptable levels by intelligent regulation of logging practices.

3. A number of forest cutting practices are known that increase the low flows typical of forest streams in late summer. This cutting usually has little adverse effect on water quality or on regional flooding. Flow increases tend to be least in dry climates while the adverse effects on water quality may be greater than those characteristic of the moist climate forests.

Suggested references for further information

1. American Society of Civil Engineers. 1975. "Watershed Management." Proceedings of a Symposium conducted by the Irrigation and Drainage Division. 781 p., illus. ASCE, 345 East 47th Street, New York.

2. Csallang, Sandor C., et al., editors. 1972. "Watersheds in Transition." Proceedings of a Symposium conducted by the American Water Resources Association. 405 p., illus. AWRA, 206 East University Ave., Urbana, Illinois.

3. Douglass, James E. 1975. "Southeastern forests and the problem of nonpoint sources of water pollution." In "Non-point sources of water pollution." Peter M. Ashton and Richard C. Underwood, editors. 314 p., illus. Virginia Water Resources Center, Blacksburg, Va.

4. Leaf, Charles C. 1975. "Watershed management in the central and southern Rocky Mountains: a summary of the status of our knowledge by vegetation types." USDA Forest Service Research Paper RM-142. 28p., illus. Fort Collins, Colorado.

5. Lull, Howard W., and Kenneth G. Reinhart. 1972. "Forests and floods in the eastern United States." USDA Forest Service Research Paper NE-226. 94p. Upper Darby, Pa.

6. Patric, James H. 1976. "Soil erosion in the eastern hardwood forest." Accepted for publication by the Journal of Forestry.

7. Rothacker, Jack. 1971. "Regimes of streamflow and their modification by logging." Pages 40-54 In Proceedings of a Symposium on Forest Land Uses and Stream Environment. School of Forestry, Oregon State University, Corvallis, Oregon.

8. Satterlund, Donald R. 1972. "Wildland Watershed Management." 370 p., illus. The Ronald Press Co., New York.

9. Sopper, William E., and Edward S. Corbett, Symposium co-chairmen. 1975. "Municipal Watershed Management." USDA Forest Service General Technical Report NE-13. 196 p., illus. Upper Darby, Pa.

10. Sopper, William E., and Howard W. Lull, editors. 1967. "International Symposium on Forest Hydrology." 812 p., illus. Pergamon Press, New York.

11. Stone, Earl. 1973. "The impact of timber harvest on soils and water." Page 427 in "Report of the President's Advisory Panel on Timber and the Environment," 541 p., illus. U.S. Gov't. Printing Office, Washington, D.C.

12. Swanston, D.N. 1974. "Slope stability problems associated with timber harvesting in mountainous regions of the United States." 14 p., illus. USDA Forest Service General Technical Report PNW-21. Portland, Oregon.

GPO 900-963

Richard Duffus 3a

FOREST MANAGEMENT IN HEMLOCK - CEDAR FORESTS

on the

QUINAULT INDIAN RESERVATION, WASHINGTON

by
John Libby
Forest Manager
Western Washington Reservation

The primary forest values on Indian lands in Western Washington are in the hemlock-cedar range and this type is predominate on the Quinault Reservation, the largest in the jurisdiction. This paper will therefore be confined to the forest management program on the Quinault, with particular emphasis on some of the more recent developments.

The Quinault Reservation is a triangular tract of land encompassing a gross land area of 189,621 acres with a net area still in trust status of 174,167 acres. Of this area, 170,080 acres is included in over 2,000 80-acre allotments. The west side of the reservation borders on the Pacific Ocean for a distance of approximately 22 miles from north to south. The northerly and southerly boundaries converge to the east to form an apex at Quinault Lake about 22 miles inland.

The entire reservation is in the fog belt where annual precipitation is high, temperatures are moderate and humidity is generally above average. The average annual rainfall varies from about 85 inches near the coast to 125 inches at Quinault Lake. Approximately 85 percent of this precipitation occurs between October 1 and April 30. This mild, moist climate results in rapid tree growth but at the same time presents problems in securing regeneration because of the heavy brush cover that frequently develops following logging.

Logging operations on the Quinault were started in 1922 and have continued since. Prior to 1930, all logging was by high-lead with steam "donkeys" furnishing the power. Transportation was almost entirely by rail.

Progressive clear cutting through the units under contract was in general practise. Reproduction following such clear-cutting was generally very good but development of large, contiguous areas of slash and reproduction created serious fire hazards. Fires did occur during the 1930's and early 1940's that denuded large areas of the cut-over lands. With no reserve seed areas to reseed these burned-over lands, results have been bad and there are presently some 12,000 acres of cut-over land in the southern portion of the reservation that are covered with bracken fern, salal brush and scattered lodgepole pine.

It was clearly indicated from this that progressive clear-cutting left much to be desired. Introduction of tractor logging in 1930, opened up the possibility of some kind of selective cutting. Seventeen different areas of various sizes and including sundry timber types and conditions were selectively logged during the thirties. In September, 1949, Mr. Perry E. Skarra, then Forest Manager at Hoquiam, reported on the results of these selective cuttings. All but four were failures. The residual stand was windthrown and deteriorated to the point where it became necessary to carry on clear-cutting operations in order to salvage the

timber values remaining. In the four areas where results were not too unfavorable, the predominant species was Douglas fir, Spruce or small pole size Cedar. In no case did Hemlock respond favorably to partial cutting.

In recent years, truck logging has replaced rail transportation and clear-cutting of alternate blocks, commonly referred to as "staggered settings", has become feasible. This method of cutting is now generally accepted as the best silvicultural system for the Hemlock-Cedar and Douglas fir forests west of the Cascade Mountain range.

As developed on the Quinault Reservation, on two large sale units now under contract, blocks of 80 to 160 acres are clear-but, leaving uncut areas surrounding them. The reserve areas will be left intact for ten to fifteen years until the slash hazard on the clear cut blocks has abated and reproduction has become established. A second cycle of cutting will cover approximately half of the reserve stands. A third and final cycle will complete the cut.

This system of staggered settings serves a dual purpose. It prevents the establishment of large areas of slash and the consequent risk of a major conflageration. Only during periods of extreme fire danger, will fire run through green timber in the hemlock-cedar forests of the west coast. Even during such periods, control is much easier in standing, green timber than in cut-over or slash areas.

The reserve or uncut areas surrounding the cut-over blocks, serve as seed sources to reforest the cut-over land. If the slash is not burned, seed in the duff will normally result in quick establishment of reproduction but the reserve stand is insurance in case a fire occurs.

While clear cutting of staggered settings is proving its merit and has been generally accepted as the best silvicultural system for west coast forests, establishment of this system has not solved all of the problems of management of these forest stands. Logging is still primarily done by high lead or skidder methods. Diesel engines have replaced the steam donkeys of earlier years and diesel trucks have largely replaced the logging railroads.

Tractor logging has not proved to be feasible except for short periods during the summer and then only on favorable terrain. During the rainy period, usually from October to May or June, tractors soon mire down and "cat-roads" become canals. Obviously logging cannot be restricted to July and August and in any event, a large percentage of the coast range is too rough for tractor logging to be used. Accordingly, high-lead and skidder logging must necessarily continue to be the standard method of harvesting the timber in west coast forests. This method of logging inevitably results in considerable breakage, particularly in cedar stands. Small trees are pulled over or broken and large volumes of wood waste remain on the ground.

Much attention has been given to this problem in recent years. With the introduction of lighter and more mobile equipment, it is becoming possible to

harvest much of the smaller material previously left to rot on the ground. During the past five years, the "short logger" has become a fixture in the west coast woods. Pre-logging and re-logging have become standard terms.

On the Quinault Reservation we have modified two of our logging contracts to provide for so-called short-log (8-foot cordwood) production and for salvage re-logging of pulpwood. Similar modifications are planned for both of our other long-term sales. Any new sales will contain such provisions in the sales contracts.

To date, pre-logging operations have been confined to cedar pole production. It is now planned that pre-logging will also be carried on in stands that contain small trees in mixture with larger ones to remove such small trees in advance of high lead logging operations. Such operations will necessarily be limited to the dry season of the year and to areas on which tractors can operate.

Salvage re-logging can and will be conducted on all areas, following logging, where appreciable volumes of salvageable material is present. Primary products to be produced will be pulpwood from hemlock and white fir and shake boards and shingle bolts from cedar.

Limited volumes of shake boards have been salvaged annually from cedar snags and windfalls for years.

This production does not begin to make use of the cedar left on the ground following high-lead logging, however, and other products will have to be developed if any appreciable progress is to be made in cleaning up the cedar waste resulting from high-lead logging.

Considerable research has been conducted in an effort to produce pulp from cedar. The writer has seen no reported results of such research but is is known that pulp can be produced from cedar. Apparently, no process has yet been developed whereby such can be done profitably but cedar pulpwood production remains a distinct probability.

The Aloha Lumber Corporation of Aloha, Washington, which is the purchaser of the timber on our Taholah Logging Unit is seriously considering the possibility of a small mill to produce small-dimension lumber from small diameter 8 and 16 foot cedar logs heretofore considered unmerchantable.

Other possibilities for cedar salvage may well be presented, but for the present, cedar shakes is the only product being produced from cedar waste.

Hemlock salvage for pulpwood, however, has already been proven to be economically feasible. Following considerable study, we recently effected a modification of one contract to provide for relogging of cut over lands in the Boulder Creek Unit. The original stand on this unit was primarily hemlock which occurred in nearly pure stands. This hemlock was relatively small with much of the merchantable sawtimber being 14 to 24 inches in diameter. Following high-lead operations, a considerable volume of material remained on the ground in broken pieces, small trees broken down, and in small trees still standing.

It soon became evident that the small trees left standing could not be expected to last through another rotation. Many blew down the first winter following logging. Others deteriorated following exposure and eventually died.

Under the terms of the recently effected modification of contract, the purchaser is now conducting salvage operations. One-hundred percent coverage of the unit is not planned for two reasons. The Boulder Creek Contract was executed in 1950 and down material on the allotments logged prior to 1954 is not useable. Also, reproduction is well established on most of the allotments logged during that same period and in many places, the value of the salvageable material is not sufficient to offset the damage that would be done to the established reproduction.

Even in these areas, however, considerable cordage will be produced from small clumps near the roads and from ragged fringes along the edges of young stands that were, and still are, reserved from cutting.

Since these operations were started, shortly after the first of the year, they have been concentrated on areas logged from one to two years ago in order to salvage material on the ground that was still useable. This phase of the operations is nearing completion and the operator will now recover the older-logged areas to pick-up the standing trees designated for salvage together with blown down trees that are still sound. At the same time, as new areas are logged, salvage operations will be conducted immediately after logging is completed in order that the broken material on the ground can be harvested before it deteriorates and so that the entire operation can be completed prior to the establishment of reproduction.

This entire operation requires and receives close supervision, particularly in the salvage of residual trees in areas where reproduction is well established. The Forest Officer in Charge must exclude all salvage operations that will result in undue damage to the reproduction and at the same time effect recovery of all useable material possible. Small blocks of small trees that will withstand wind and weather and can reasonably be expected to live through the next rotation must be preserved. There has to be almost daily supervision and advance layout of the operation in close cooperation with the operator. The snap shots on the following page illustrate some of the problems encountered.

The salvage operations described above have already demonstrated their value. Seven allotments, totalling 440 acres have been covered or are now being relogged. Total production to date from these seven allotments has been 1,796.51 cords for which the allottees have received $3,575.59. Saw log production from these same allotments prior to salvage operations was 14,961,740 bd. ft. On the basis of 2 cords per M bd. ft., the volume salvaged is 6 percent of the saw log production, and the salvage is not yet completed.

As more efficient methods of handling this small material are developed and as new uses are developed for cedar and other species, the salvage recovery can be still further increased. At the present time we are making definite plans to produce salvage from current salvage operation. This is not as inane a remark as it appears.

Blagen's Sawmill in Hoquiam is installing a new type of drum barker that will handle small, short pieces of wood up to four feet in length. On the "short log" and hemlock salvage operations on the Quinault Lake and Boulder Creek Logging Units, large piles of short ends develop at the landings. We are making definite plans with the contractors on these units for the salvage of this material.

We have come a long way in improving our Management of our hemlock and cedar forest stands: from progressive clear-cutting to the staggered settings; from railroad to truck logging. We have made a definite start toward improving our utilization of the forest stand. We still have a long way to go. We do not have the facilities for research to develop new uses for our woods waste but we can and must be ready to take advantage of such uses when they are developed by industry.

John W. Libby

John W. Libby,
Forest Manager.

Date: October 13, 1955

JWL/jw