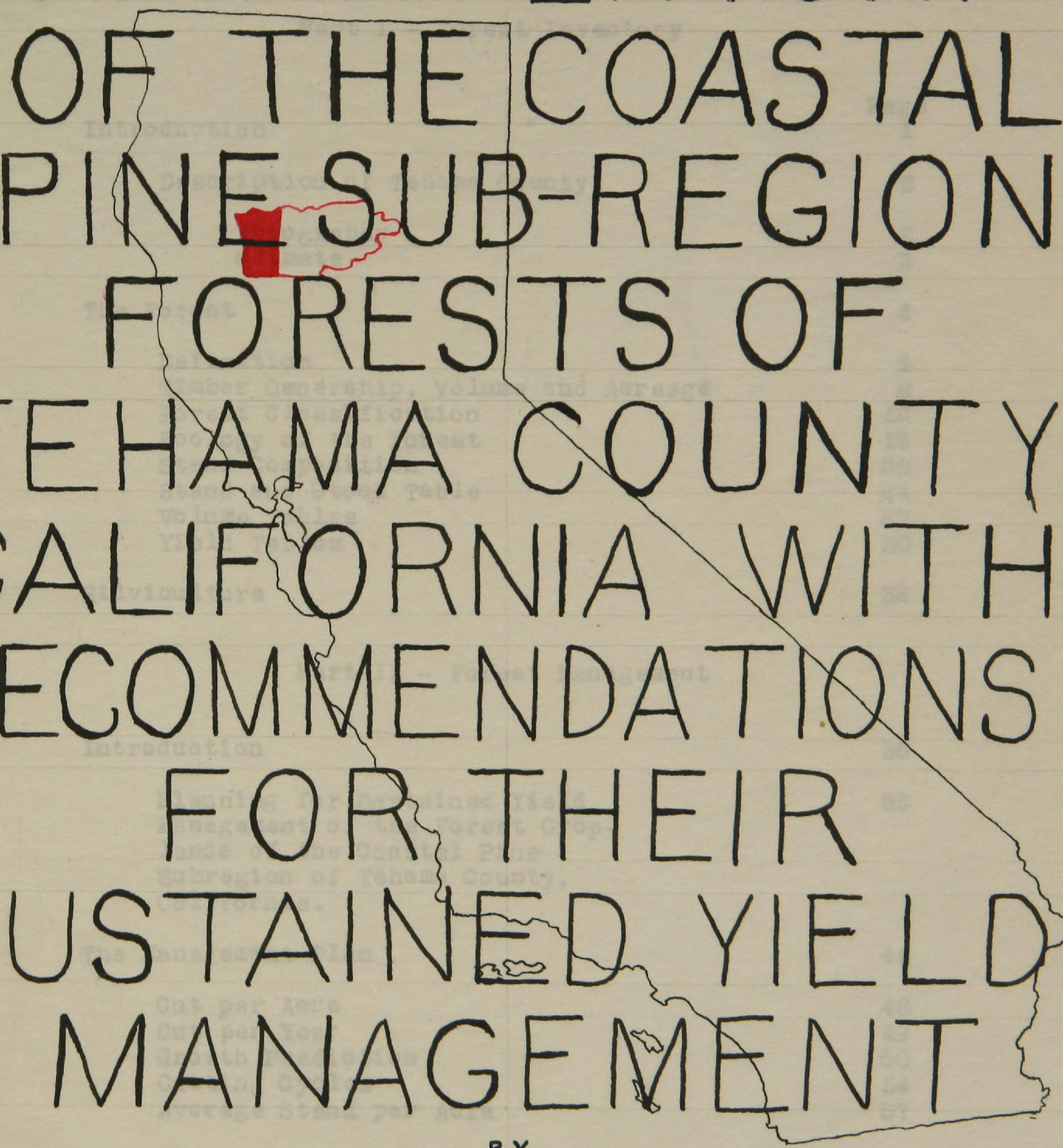
AN INVENTORY OF THE COASTAL PINE SUB-REGION FORESTS OF TEHAMA COUNTY CALIFORNIA WITH RECOMMENDATIONS FOR THEIR SUSTAINED YIELD MANAGEMENT



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T A B L E   O F   C O N T E N T S

Part I - Forest Inventory

Part II - Forest Management

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THE FOREST INVENTORY

I N T R O D U C T I O N

INTRODUCTION

The purpose of this report is to examine the forests of that part of Tehama County, California, in the Coastal Sub-region of the Pine Region; and to investigate the potentialities of these forests for sustained-yield management and continued production of forest products.

The existing forests will be classified by type, density, age, and site quality. The further purpose, then, of the report is to arrive at a maximum allowable annual cut from a consideration of all available known factors influencing the forests, and to describe the methods of management necessary to arrive at this maximum allowable cut.

The intention of the author is to report extensively on the forest, rather than in an intensive manner. While an intensive appraisal of the area is of eventual necessity, the information about the area and the intended scope of this report are of such a nature as to preclude this.

DESCRIPTION OF TEHAMA COUNTY

Tehama County is located in North-central California. The county seat and largest city in the county is Red Bluff.

Map supplement I indicates the vegetation types into which the county is divided.

TOPOGRAPHY

A cross section of Tehama County taken in an east-west direction would resemble a wide shallow trough with the Sierra Nevada Mountains rising in the east and the Coast Mountains in the west. The Sacremento River runs in a southerly direction, approximately bisecting the county. The entire county is in the watershed of the Sacremento River.

Going westward from the Sacremento River the land rises from an elevation of close to sea level to the height of land which forms the western boundary of the county. Immediately west of the western boundary of the county the topography decreases somewhat in elevation and the watershed drains into the Pacific Ocean via the Middle Eel and tributary streams.

This summit which forms both the watershed and county boundary is at an elevation of 5000 to over 8000 feet. Highest peak in the Coast Mountains of the county is South Yolla-Bolly Mountain in the northwest corner of the county with an elevation of over 8000 feet.

The topography rises very abruptly from a point a mile or two west of Paskenta where the elevation is less than 1000 feet, to elevations of over 6000 feet ~~along~~ only a few miles further west.

The principle drainage of the timbered sections in the western portion of the county is Thomes Creek and tributaries and Elder Creek, both of which join the Sacremento River north of the city of Corning.

In the remainder of this report all discussions and statistics apply to that part of the forests of Tehama County which lie to the west of the Sacremento River, unless otherwise noted.

CLIMATE

The lowlands along the Sacremento River and for about twenty five miles east and west are characterized by an extremely warm, dry climate. Corning is the center of an olive producing area which is very warm and dry in climate, characterized by a complete absence of precipitation during the summer months.

However, as one moves westward and increases in elevation from Paskenta (Elevation 790 feet) which is about twenty miles west of the Sacremento River, the climate becomes cooler and more humid, as an influence, of course, of the rapid increase in elevation. The timber begins to appear in commercial stands about 10 miles west of Paskenta at an elevation of about 3500 feet where the yearly rainfall averages about 25 inches. (See County Isohytal Map, Map Supplement II)

T H E

F O R E S T

THE FOREST

The forest is found above 3000 feet elevation and is greatest in extent and density in the southwestern part of the area. Timber line is at about 6500 feet elevation but varies greatly seeming to be more dependent on exposure and soil than upon elevation alone. The following definitions of terms used in this report are taken from Forest Survey Release No. 4 and unpublished manuscripts of the California Forest and Range Experiment Station.

DEFINITION

The forest land includes (1) all timber cropland whether or not tree covered, (2) all other conifer, woodland, and woodland-grass types, and (3) chaparral and the generally intermingled coastal sagebrush of primary value for watershed purposes. It comprises both commercial and noncommercial forest land.

Commercial forest land is timber cropland that has not been officially withdrawn from commercial timber use. It comprises:

1. Available areas where such factors as topography and accessibility and character of timber are judged favorable for economic operation of saw-timber stands within the next 40 years.

2. Unavailable areas, where such factors as topography and accessibility and character of timber are judged unfavorable for economic operation within the next 40 years.

3. Recreation areas, including roadside scenic strips considered to be of such high recreational value that for large areas the usual form of timber management would not apply -- any cutting being less than usual and primarily to benefit the stand for recreation purposes.

Noncommercial forest land includes:

1. Timber cropland actually withdrawn from commercial timber use for such purposes as parks, preserves, and wilderness areas.

2. All other forest land unsuitable for growing commercial timber crops.

The forest land ownership is divided, for simplicity, between the public and private ownership.

Public ownership includes all timber cropland owned by the people of a particular political entity. In this case the United States of America, the State of California, or Tehama County. It comprises the following classifications of ownership:

1. Forest Service ownership includes all timber cropland owned by the people of the United States and dedicated as a National Forest. In Tehama County this designates the Mendocino National Forest and Middle Eel - Yolla Bolly Wilderness Area.

2. Public Domain ownership includes all unpatented timber cropland owned by the people of the United States and set aside for homesteading.

3. State and County ownership includes all timber cropland owned by the people of the State of California and/or by the people of Tehama County.

Private ownership includes all timber cropland owned by particular individuals or by particular corporate bodies.

In addition to ownership classification and use dedication, the forest timber cropland is further defined by the character of the stand and by the species of commercially valuable timber trees. These are defined as follows:

Stand character. The forest is composed almost entirely of mature and over-mature virgin timber to the extent that 99.9% of the timber is thus classified. The small area of second growth timber, 2,420 acres and .1% of the timber volume, is a result of fires and landslides within the past 120 years. Therefore, the stand is divided only into:

1. Old growth timber includes all timber cropland on which over 5% of the ground is covered by timber growth, with over 50% of the coniferous canopy made up of mature trees.

2. Young growth timber includes all timber cropland on which over 5% of the ground is covered by timber growth, with less than 50% of the coniferous canopy made up of mature trees.

The commercially valuable timber species, listed in the order of their occurrence by volume, are:

1. Ponderosa Pine (Pinus ponderosa)
2. Douglas Fir (Pseudotsoga taxifolia)
3. Sugar Pine (Pinus lambertiana)
4. White Fir (Abies concolor)
5. Incense Cedar (Libocedrus decurrens)
6. Red Fir (Abies magnifica)
7. Lodgepole Pine (Pinus contorta)

Ownership and use-dedication by species and stand character are summarized in the following table by area in acres and by volume in feet board measure, Scribner Decimal C Rule.

FOREST AREA IN PUBLIC AND PRIVATE OWNERSHIP. VOLUME OF OLD GROWTH AND YOUNG GROWTH TIMBER BY SPECIES

Tehama County, Coast Range Pine Subregion

Available Timber

	Species	Forest Service	Private	Public Domain
Old-Growth	Ponderosa Pine	422,147	301,558	9,786
	Sugar Pine	161,395	136,453	4,348
	White Fir	136,382	127,873	958
	Douglas Fir	414,983	290,012	8,872
	Incense Cedar	27,362	19,601	686
	Red Fir	4,524	4,935	
	Total	1,166,793	880,432	24,650
	Acres	68,810	56,740	1,940
Young Growth	Ponderosa Pine	615	40	
	Sugar Pine	246	20	
	White Fir	246	20	
	Douglas Fir	861	60	
	Incense Cedar	--	--	
	Red Fir	--	--	
	Total	1,968	140	
	Acres	1,230	200	
Unstocked	Acres	4,960	360	

FOREST AREA IN PUBLIC AND PRIVATE OWNERSHIP. VOLUME OF OLD GROWTH AND YOUNG GROWTH TIMBER BY SPECIES

Tehama County, Coast Range Pine Subregion

Recreation and Roads

	Species		Forest Service	Private	Public Domain
Old-Growth	Ponderosa Pine		35,875	23,882	
	Sugar Pine		21,933	22,258	
	White Fir		30,763	35,185	
	Douglas Fir		32,470	26,788	
	Incense Cedar		4,082	3,871	
	Red Fir		1,184	336	
	Lodgepole Pine		36	20	
		Total	126,343	112,340	
	Acres		6,420	5,400	
Young Growth	Ponderosa Pine			3,869	
	Sugar Pine			2,312	
	White Fir			2,035	
	Douglas Fir			3,149	
	Incense Cedar			440	
		Total		11,805	
Unstocked	Acres		3,980	1,500	

FOREST AREA IN PUBLIC AND PRIVATE OWNERSHIP. VOLUME OF OLD GROWTH AND YOUNG GROWTH TIMBER BY SPECIES

Tehama County, Coast Range Pine Subregion

Parks and Primitive Areas

	Species	Forest Service	Private	Public Domain
Old-Growth	Ponderosa Pine	187,396	5,891	2,378
	Sugar Pine	99,793	3,665	902
	White Fir	46,199	3,071	574
	Douglas Fir	292,975	8,544	2,255
	Incense Cedar	16,137	486	246
	Red Fir	5,339	950	123
	Total	647,839	22,607	6,478
	Acres	37,550	1,070	530

Unavailable

	Species	Forest Service
Old Growth	Ponderosa Pine	144
	Sugar Pine	116
	White Fir	156
	Douglas Fir	300
	Incense Cedar	32
	Red Fir	24
	Total	772
	Acres	40

A consideration of the foregoing table shows that of the forest area that part which is available for commercial utilization represents 2,073,983,000 feet board measure, 69% of the total volume; and 134,240 acres, 70% of the total area.

Of this available timber 1,193,411,000 feet board measure, 58% of the available volume; and 76,940 acres, 57% of the available area is owned by the public. 880,572,000 feet board measure, 42% of the available volume; and 57,300 acres, 43% of the available area is privately owned.

The average stand per acre on all of the available timber cropland is 15,450 feet board measure. The average stand per acre of the available old growth timber is 16,259 feet board measure. The average stand per acre of the available second growth timber is 1,474 feet board measure.

FOREST CLASSIFICATION

The forest was surveyed and mapped and the land classification symbols used on the map (Map Supplement III) are explained in the following legend:

(A) Initial (letter) symbol segregates timber cropland sites, subdivided by present condition, from lands unsuitable for timber cropping.

O Old growth timber. Timber cropland on which over 5% of the ground is covered by timber growth, with over 50% of the coniferous canopy made up of mature trees.

R Young growth - old growth timber. Timber cropland on which over 5% of the ground is covered by timber growth, with from 20 to 50% of the coniferous canopy made up of mature trees.

Y Young growth - sawlog size. Timber cropland on which over 5% of the ground is covered by timber growth, with less than 20% of the coniferous canopy made up of mature trees and more than 20% of the young trees over 12 inches DBH.

S Young growth - under sawlog size. Timber cropland on which over 5% of the ground is covered by timber growth, with less than 20% of the coniferous canopy made up of mature trees and less than 20% of the young trees over 12 inches DBH.

D Apparently unstocked. Timber cropland on which less than 5% of the ground appears to be covered by timber growth.

N <u>Nontimber sites</u>. Areas apparently lacking the climatic or soil qualities essential for the production of commercial timber crops, and deforested areas now cultivated for farm crops or urbanized.

(B) Number immediately following symbols O, R, Y, or S indicates density of the existing timber stand (all age classes combined).

1 <u>Well stocked</u>. Timber growth covering over 50% of the ground.

2 <u>Moderately stocked</u>. Timber growth covering from 20% to 50% of the ground.

3 <u>Poorly stocked</u>. Timber growth covering from 5% to 20% of the ground.

(C) Numbers joined to the foregoing letter and letter-number symbols designate the present or potential vegetation cover classification.

Those immediately following O1 or 2, R1 or 2, Y1 or 2, or S1 or 2 and in second position following O3, R3, Y3 or S3 indicate the species composition of the existing timber stand.

Those immediately following O3, R3, Y3, S3 or D indicate the existing cover class other than timber; those following N, including timber.

Those in second position following D indicate the timber species - class to which the areas climatically belong.

1 <u>Desert</u>. Vegetation consisting entirely or nearly so of the characteristic Mojave and Colorado Desert shrubs, together with included barren areas.

1a Barren. Vegetation or use insufficient to satisfy any of the following classes.

2 Cultivated, urban, and industrial.

3 Woodland plantation. Plantations of eucalyptus or other nontimber trees.

4 Grassland. Herbaceous vegetation covering over 50% of the ground on areas not excluded by mixture with trees or Great Basin sagebrush.

5 Coastal sagebrush. California sagebrush, coyote brush, buckwheats covering over 50% of the ground on areas not excluded by mixture with trees.

5a Great Basin sagebrush. Big sagebrush, bitterbrush covering over 5% of the ground on areas not excluded by mixture with trees.

6 Chaparral. Manzanitas, scrub oaks, chamise, etc., covering over 50% of the ground on areas not excluded by mixture with trees.

7 Woodland. Broadleaved trees, chiefly live oaks, covering over 50% of the ground on areas not excluded by mixture with timber trees or herbaceous vegetation.

8 Woodland-Grass. Mixtures of broad-leaved trees and herbaceous vegetation each covering 20% or more of the ground on areas not excluded by mixture with timber trees.

9 Pinon and Juniper. Pinon and juniper covering over 5% of the ground on areas not excluded by mixture with timber or broadleaved trees.

10 Miscellaneous conifers. Knobcone pine, Digger pine, Bishop pine, etc., covering 20% or more of the ground on areas not excluded by mixture with timber trees.

11 Pine (timber). Ponderosa Pine and Sugar Pine cover over 80% of the ground covered by timber growth, the remainder in Douglas Fir and Incense Cedar. This type occurs mainly on south and west facing slopes at elevations of 3500 to 6500 feet and is densist and of best quality from 4500 to 5500 feet elevation.

12 Pine - Douglas Fir (timber). This type is characterized as a mixture of the commercial pines (Ponderosa and Sugar) with Douglas Fir and to a much lesser extent Incense Cedar, White Fir, and Red Fir in which the pines cover 20% to 80% of the ground occupied by timber growth and the pines and Douglas Fir cover over 60% of the ground occupied by timber growth. This type covers a large majority of the area and occurs on all exposures at elevations of 3500 to 6500 feet.

13 Redwood (timber). Redwoods cover 20% or more of the ground occupied by timber growth. This type does not occur in Tehama County and is included here only because it appears a short distance to the west of the county boundary.

14 Douglas Fir (timber). Douglas Fir covers over 80% of the ground occupied by timber growth, or mixtures of Douglas Fir and the true firs in which Douglas Fir covers 20% or more of the ground. This type is sometimes mani-

fested in a sub-type in which Douglas Fir covers approximately 80% of the ground, with the remaining 20% divided between Sugar Pine (15%) Incense Cedar (3%) and the true firs (2%). The Douglas Fir type is almost invariably found on north facing slopes or in drainages facing north and is usually found at higher elevations than either the Pine or Pine-Douglas Fir types, frequently between 5500 and 6500 feet elevation.

15 Fir (timber). The true firs (white and red) cover over 80% of the ground occupied by timber growth. The true fir type is rarely found below 6000 feet elevation and is characterized by dense, often pure, frequently stagnate stands of comparatively small trees (in diameter). The timber is usually of very poor quality especially at the upper altitudinal limits of the type. Large areas of this type often represent negative surplus stands of no commercial value in normal times.

16 Subalpine. Foxtail Pine (Pinus balfouriana), Lodgepole Pine (Pinus contorta), Mountain Hemlock (Tsuga mertensiana), and rarely Western White Pine (Pinus monticola) covering over 5% of the ground not excluded by mixture with timber trees. This type is found just below or at timber line, usually over 6500 feet in elevation. It usually forms a sparse ground cover of prostrate shrub-like trees and is of no commercial importance.

(D) Number not connected by a dash with other symbols and usually placed below the others designate productive quality of the timber cropland. These symbols represent general site quality only. Site quality and designation for Tehama County are discussed at greater length elsewhere in this report.

1. Very low site
2. Low site
3. Medium site
4. Medium - high site
5. High site.
6. Extremely high site

Almost the entire area considered in this report as timber cropland falls in the medium site (3) class with only one area of D-6-12 designation classified as low site (2) class.

ECOLOGY OF THE FOREST

The forest is characterized by stands of medium density and medium site of medium value. The principal species is Ponderosa Pine, which with Sugar Pine make up the most valuable, by far, of the species. (See Chart for stumpage comparisons). The pine here is of very good quality and represents the climax species on better sites with South to West exposures at middle altitudes. The Douglas Fir, while second only to Ponderosa Pine in occurrence, is of considerable less value. The Douglas Fir of Tehama County is of poorer form and less quality than the trees of the Douglas Fir region proper in western Oregon and Washington, and suffers by competition in normal markets, particularly in structural timbers grades. It is, however, next to the pines in value in the forest. Red Fir is usually included with Douglas Fir in shipments from the sawmill. Incense Cedar has a positive market value as lumber, but is often a negative surplus species in the forest due to the characteristically high percentage of decay, as is true to a lesser extent of White Fir.

Type transition zones are often poorly defined, especially altitudinally, with clearer boundaries at changes in exposure.

As previously noted in the type designation definitions, the Douglas Fir type is usually restricted to North facing slopes, and although its place in the succession is unknown, it is considered as a climax on steep north slopes.

In instances where Pine type areas at lower elevations are burned or clear-cut they are frequently subsequently captured by the Pine-Douglas Fir type inasmuch as the exposed mineral soil is preferred by Douglas Fir seeds.

In the old growth forest advance reproduction is either lacking or sparse for a number of reasons. Sugar and Ponderosa Pine are both particularly intolerant and cannot survive competition with other seedling species which have a height advantage. In clearings and large openings in the forest, pine seedlings which become established at the same time as fir seedlings usually survive because of their faster height growth. Douglas Fir and the true firs, on the other hand, require a partial canopy to protect the moisture relationship in the soil, and are comparatively tolerant, especially at an early age. With increasing age Douglas Fir becomes less tolerant and gradually loses out to the true firs.

Incense Cedar is a prolific seed bearer, bearing large crops every few years. Cedar seedlings are particularly evident in the advance reproduction when it is at an early age -- but gradually disappear with increasing age because although fairly tolerant, Cedar is a slow grower and is soon overtopped by both pine and fir seedlings of the same age.

Subsequent reproduction after cutting is a matter of conjecture in this area as there has been no cutting prior to 1945. This problem is discussed at greater length in the section on Silviculture.

Ecologically, the forest types have occasionally been changed by a lowering of the soil quality of the area due to overgrazing by stock in the past and by repeated burnings. Certain areas have been captured by manzanita and other chaparrals for this reason -- and this would pose a problem in cutting on the poorer sites.

On the other hand, fairly heavy cutting is indicated in order to favor the establishment of pine seedlings in the residual stand.

Sugar pine, although a more regular seed bearer than Ponderosa Pine, is very difficult to reproduce because of the low viability of the seeds - often less than 20% of the seed is viable - and the exacting seed bed requirements of the species.

Grazing restrictions imposed by the forest service, increased reluctance on the part of stockmen to maintain the greatly reduced herds in the rugged mountain country, and vastly improved fire protection and suppression methods and coverage will all contribute greatly to improving soil conditions in the forest. However, site improvement is, at best, a lengthy process and is, in the case of many particular stands, "closing the barn door after the horses have fled."

Another factor of importance in the ecological character and composition of the forest in this area is the peculiar climatological zone. Inasmuch as the area lies to the east of the height of land between the Sacramento River and the Pacific Ocean the rainfall, although greater than many Sierra sites, particularly in the Eastside Sierra Pine Sub-Region, is insufficient, in combination with the impoverished soil, for the best possible tree growth.

Repeated fires over large areas both as a result of lightning and incendiarism on the part of stockmen have been the greatest single factor in prohibiting advance reproduction and the establishment of an understory.

STAND COMPOSITION

The stand over the entire area of available old growth timber is composed of the commercial timber species in the following proportions:

	Species	Volume	%
	Ponderosa Pine	733,491 M	35.4
Combined	Douglas Fir	713,867 M	34.4
Combined	Red Fir	9,459 M	.5
	Sugar Pine	302,196 M	14.6
	White Fir	265,213 M	12.8
	Incense Cedar	47,649 M	2.3
	Total	2,071,875	100.0

The high value pines constitute 1,035,687 M feet board measure or almost exactly 1/2 of the available volume.

In the formulating of sustained yield management plans stand and stock tables are indispensible. Separate stand tables are necessary for each separate cutting compartment because of the great differentiation in species composition and volume from acre to acre in this forest. The stand and stock table which follows is for the entire available old-growth forest and is conceivably impossible of application on any particular acre. However, in arriving at an allowable maximum annual cut and in formulating an extensive plan of sustained yield forest management for the forest it is very necessary.

STAND AND STOCK TABLE

TEHAMA COUNTY, COASTAL PINE SUB-REGION

Typical Acre

DBH	No. of Trees	Basal Area	Volume, ft. b. m.	% Vol. per Dia. class	Vol. ft. b. m. per Sq. ft. B. A.
12	4.24	3.33	280	1.72	84.2
14	3.85	4.11	377	2.32	91.8
16	3.14	4.38	487	3.00	111.2
18	2.54	4.48	579	3.56	129.3
20	2.25	4.91	675	4.15	137.3
22	1.91	5.04	786	4.83	156.0
24	1.62	5.09	874	5.38	171.9
26	1.36	5.02	949	5.84	188.9
28	1.13	4.84	1008	6.20	208.1
30	.94	4.62	1038	6.39	224.4
32	.78	4.36	1032	6.35	237.0
34	.65	4.09	1016	6.25	248.1
36	.55	3.89	985	6.05	253.3
38	.44	3.46	930	5.72	268.8
40	.35	3.06	844	5.18	275.8
42	.29	2.79	792	4.87	275.7
44	.22	2.32	687	4.23	296.0
46	.17	1.96	604	3.72	308.0
48	.12	1.51	479	2.94	317.3
50	.09	1.23	400	2.46	325.2
52	.06	.88	296	1.82	336.4
54	.05	.80	270	1.66	337.6
56	.03	.51	178	1.09	349.0
58	.03	.55	194	1.19	352.7
60	.02	.39	140	.86	359.0
62+	.02	1.04	360	2.22	346.0
Total	26.85	78.66	16,260	100.00	

The typical average acre in the foregoing stand and stock table is composed of the commercial timber species in the following proportions:

	Volume	Per-cent
Ponderosa Pine	5,754	35.4
Sugar Pine	2,377	14.6
Douglas Fir, Red Fir	5,673	34.9
White Fir	2,081	12.8
Incense Cedar	375	2.3
	16,260	100.0

The percentage distribution for the entire stand is roughly applicable to each individual diameter class with the exception of White Fir which is rarely found above about 48 inches in diameter.

In the formulation of an intensive plan of management, stand and stock tables are necessary for each cutting compartment as already indicated. Changes in type, per-cent of species composition in types, site quality and density each necessitate different control tables. It is obviously impossible to include all these different stand tables in this report, - such a detailed survey of the forest has not as yet been made. However, to indicate their construction and application I have included nine stand tables for the true fir type at elevations between 6000 and 6500 feet. They illustrate stands of combinations of three degrees of stocking on sites of three qualities. These stands are peculiar because they average over 90% White Fir. Stands of high density on Site I are practically non-existent in this area -- and these stand tables have been statistically constructed from an extrapolation of data for stands of poorer site quality and less density, in order to make the study of the true fir type comprehensive.

VOLUME TABLES

Following are included volume tables for the forest area under discussion in this report. The bulk of the forest survey was computed by the diameter class volume tables which were constructed by site classes, from total height volume tables furnished by the Forest Service. The total height curves, by site class, are self explanatory. All volumes are by Scribner Decimal C Rule, the standard Forest Service Rule for California.

VOLUME TABLES

Tehama County Coastal Pine Subregion

Volumes by Scribner Decimal C

DBH	Ponderosa Pine Site I	Ponderosa Pine Site II	Ponderosa Pine Site III	Sugar Pine Site I	Sugar Pine Site II	Sugar Pine Site III	Douglas Fir Site I	Douglas Fir Site II	Douglas Fir Site III
12	13	12	11	4	3	2	6	4	3
14	18	15	14	6	5	4	11	8	6
16	23	20	17	17	10	6	19	14	10
18	31	26	21	23	16	12	27	24	14
20	43	34	26	35	25	22	37	29	22
22	58	47	36	47	39	32	49	37	26
24	81	63	49	66	48	41	63	48	32
26	105	83	66	86	64	55	78	60	42
28	131	106	87	108	83	71	95	77	57
30	159	133	112	133	104	92	112	94	66
32	189	160	135	159	132	115	130	109	87
34	221	188	162	189	160	141	150	127	101
36	261	219	191	221	190	169	171	138	116
38	302	257	224	256	222	201	195	168	132
40	348	294	256	297	257	256	222	189	153
42	394	338	293	342	296	274	249	210	174
44	444	386	333	391	340	308	282	238	197
46	476	439	383	444	390	347	320	271	229
48	559	492	431	503	444	389	351	307	267
50	624	550	484	562	498	436	387	341	295
52	685	611	540	624	559	480	420	372	326
54	757	679	600	685	623	550	453	397	347
56	833	744	666	748	685	610	490	440	377
58	906	814	731	807	747	675	523	465	403
60	984	886	799	867	808	740	561	500	436
62	1062	956	875	927	866	796	593	532	460
64	1137	1026		987	925	850	633	584	496
66	1220	1125		1044	988	925	664	597	523
68	1298	1190		1106	1048	960	695	638	549
70	1376	1245		1165	1095		728	662	574
72							761	693	605
74							800	725	635

VOLUME TABLES

Tehama County Coastal Pine Subregion

Volumes by Scribner Decimal C

DBH	White Fir			Incense Cedar		
	Site I	Site II	Site III	Site I	Site II	Site III
12	5	4	3	5	4	2
14	13	9	5	7	5	3
16	20	15	9	9	6	5
18	30	20	15	15	11	8
20	40	31	22	20	15	11
22	54	43	32	25	21	16
24	73	56	43	36	28	22
26	94	72	55	46	36	29
28	116	91	68	58	44	35
30	141	110	82	70	55	43
32	167	133	98	82	67	52
34	194	158	117	95	78	62
36	226	184	138	108	90	72
38	236	212	162	122	103	85
40	290	241	189	138	118	100
42	321	272	220	154	131	112
44	355	306	251	170	147	128
46	392	343	288	186	165	142
48	431	382	325	204	180	158
50	473	422	365	221	198	175
52	520	462	404	240	216	195
54	569	506	445	262	236	215
56	624	560	496	285	265	240
58				309	291	
60				335	314	
62						
64						
66						
68						
70						
72						
74						

YIELD TABLES

All yield tables available for California have been compiled from data collected in naturally developed stands which have not been thinned, and so the data are presented for stands down to diameter limits below the point of utilization common to the western forests. The adaptation of normal yield tables to the area in question is further complicated by the fact that almost all of the yield tables available, and applicable to the area, are for pure stands of the commercial species; and pure stands, except in the case of the White Fir type, are very rare.

Various published and unpublished yield tables have been considered, including:

Dunning, D., and Reineke, L. H., Preliminary Yield Tables for Second Growth Stands in the California Pine Region. U. S. D. A. Tech. Bull. 354. 1933.

McArdle, R. E., New Yield Tables for Douglas Fir. West Coast Lumberman 50. 1926.

McArdle, R. E. and Meyer, W. H., The Yield of Douglas Fir in the Pacific Northwest. U. S. D. A. Tech. Bull. 201. 1930.

Meyer, W. H., Yield of Even-aged Stands of Ponderosa Pine. U. S. D. A. Tech. Bull. 630. 1938.

Schumacher, F. X., Yield, Stand and Volume Tables for Douglas Fir in California. Calif. Agr. Expt. Sta. Bull. 491. 1930.

Schumacher, F. X., Yield, Stand and Volume Tables for Red Fir in California. Calif. Agr. Expt. Bull. 456. 1928.

Schumacher, F. X., *Yield, Stand and Volume Tables for White Fir in the California Pine Region*. Calif. Agr. Expt. Sta. Bull. 407. 1926.

Show, S. B., *Yield Capacities of the Pure Yellow Pine Type on the East Slope of the Sierra Nevada Mountains in California*. Jour. Agr. Research 31. 1925.

Terry, E. I., *Yield Tables of Western Forests*. Forestry Quarterly 8. 1910.

None of these is strictly applicable and it seems impossible to find a yield table for the old growth, all aged, mixed species forest of the area in question. I have tried to adapt these to conditions on the area with the addition of the only yield table I could find on ~~even~~ all aged stands:

Meyer, W. H., *Growth in Selectively Cut Ponderosa Pine Forests of the Pacific Northwest*. U. S. D. A. Tech. Bull. 407. 1934.

This publication, while prepared for use in Oregon and Washington for pure Ponderosa Pine stands, is applicable in many instances to the area under consideration.

In the construction of a Control Table and Stand and Stock Table for the forest the methods used are adapted from two publications in the most part. They are:

Briegleb, P. A., *Use of Yield Tables for Forest Survey Growth Estimates*. General Publication of the Pacific Northwest Forest and Range Experiment Station. 1947.

Matthews, D. M., *Management of American Forests*. McGraw-Hill. 1935.

S I L V I C U L T U R E

SILVICULTURE

The forests of western Tehama County would respond well, at least in theory, to many different silvicultural practices, although in practice circumstances peculiar to the area limit the use of the various methods.

It is to be noted that the forest is composed to the extent of 84.4% of three species; Ponderosa Pine, Sugar Pine, and Douglas Fir; all of which are characterized by silviculturists as being particular responsive and sensitive to the various methods of cutting in which the aim is to produce, over a long period of time, the greatest amount of timber from the cropland.

The biggest problem confronting the forester in his choice of silvicultural methods is the difficulty in increasing, or even in maintaining the proportion of the more valuable species (the two pines) in the old-growth forest.

In view of this problem, clear-cutting the area with some allowance for natural reproduction of the desired species would seem to be indicated. The seed tree method immediately jumps to mind whereby the stand would be clear cut except for scattered seed trees of the two valuable pine species. By eliminating all species of inferior value from the stand the reproduction must, of necessity, be entirely of pine.

In practice there are many objections to this plan, both economic and ecological. In the reproduction of Ponderosa Pine a dilemma is at once noted, and was already mentioned in the section on the forest's ecology. Ponderosa Pine, for best germination and subsequent survival and growth, requires, and all seem to be critical factors:

1. An exposed mineral soil or ash seed bed.
2. The presence in the seed bed of moisture in quantity.
3. Protection; especially during the earlier stages of development, from sun scald and the too rapid evaporation of surface moisture; by an overhead canopy (the residual stand).
4. Freedom from competition by the residual stand for light, soil nutrients, and water.

Any attempt to reconcile these factors is difficult in the extreme. To quote from Baker:*

> "Mineral soils or mineral soil and ashes make the best seed bed, but the mineral soils are usually so shallow that drouth kills all the seedlings every year."

And:

> "The residual stand ... by its shade reduces evaporation and increases germination, but it cuts off light and heat and with root competition renders areas within its influence poor for establishment of reproduction."

In further consideration of this evidence it is to be noted that the soils in this area are particularly shallow and in many instances almost sterile from the repeated burning and overgrazing already noted.

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*Baker, F. S., Theory and Practice of Silviculture. McGraw-Hill. 1934. Pp. 435 to 441.

Therefore, the seed tree method seems to be ruled out inasmuch as it would leave this shallow soil fully exposed to the sun with resulting high moisture evaporation and its detrimental effects on the establishment of reproduction. Furthermore, the area is characterized by summer droughts and there is usually little, if any, precipitation from June 15 to September 15.

Under the present methods of logging and utilization practices, the seed tree method must also be ruled out on an economic basis. The rugged character of the topography and the relative inaccessibility of much of the area results in comparatively high logging costs which set the marginal tree at a diameter where it would not be economically feasible to clear cut the stand.

In the future, changes in utilization and improved and cheaper methods of logging may, and probably will, result in forcing the marginal tree down to a smaller diameter. For this reason, and because it results in improving the species composition of the stand and therefore its value, the seed tree method should not be entirely ignored. Research into its application is very necessary and almost entirely lacking. In particular, ecological and silvical studies of the seed tree method may result in drastic changes in the existing beliefs about its application.

This leaves some type of partial cutting as the indicated method, and in practice this means a single-tree selection method of cutting.

Selective cutting, both on a silvicultural and on an economic basis, is advocated by the Forest Service for the area and is applied by the majority of the private operators.

Selective cutting on a single-tree selection basis serves a number of purposes in this area, namely:

1. Over-mature decadent high risk trees are removed and the entire area is cut over in a shorter period of time than in clear cutting -- thereby salvaging many of these high risk trees which might otherwise be lost to the forest.

2. Logging costs are kept at a minimum. Many authors have shown that the costs per thousand board feet are reduced when only the larger trees are taken.

3. Diseased and insect infested trees are more quickly removed from the forest, leaving a healthier more productive stand.

4. A residual stand is left to furnish recurrent cuts, provide a seed source, and protect the soil.

5. The second cut can be made after a shorter interval than in clear cutting.

The method of single-tree selection as adapted to the old-growth, overmature forests of the area results in removing a large part of the stand, usually 70% or more, and thereby leaving a small residual volume for a second cut to be postponed 40 or more years. This method of cutting will result in elimination of the older age classes within one or two cycles, conversion to younger and younger ages, and, probably, final transition into an even aged stand, or at the least, a two-storied forest.

A brief example will serve to illustrate this point. Taking a typical acre of 16,260 feet board measure and subjecting it to a 70% cut leaves a residual volume of 4,878 board feet on the acre. On an average site, under average growing conditions, when the second cut is made in, say 40 years, this residual stand will have increased to about 8,800 board feet.* If the plan in the second cut is to remove 70% again the cut will be 6,160 board feet.

This gives a total for the first and second cut of 17,542 board feet, 1,282 board feet more than the original volume, before cutting. This demonstrates that after the second cut the residual stand of 2,640 board feet, 16.25% of the original volume, is entirely in trees which were less than 12 inches DBH and contained no volume at the time of the first cut. Even with better than average growth, the largest trees left after the second cut couldn't be over 20 inches DBH. This reduction in the average and maximum diameters of the trees, combined with the long cutting cycle, and the heavy (70%) cuts would indicate conversion to the even aged or two storied forest.

In addition, many areas lack a sufficient number of trees and seedlings in the 0 inch to 12 inch diameter classes, and this would also effect a compromise from the theoretical all-aged selection forest.

In outlining the type of selective cutting which can best be applied a method of tree selection must be described. Dunning's tree classification which was worked out for Ponderosa Pine for California is the classification used by the Forest

*Meyer, W. H. Growth in Selectively Cut Ponderosa Pine Forests in the Pacific Northwest. U. S. D. A. Tech. Bull. 407. 1934. Pp. 24.

Service and is applicable in this area if used with discretion.

Although constructed primarily for use in classifying Ponderosa and Sugar Pine, it can be applied, at least in principle, to Douglas Fir also. An explanation of Dunning's Tree Classes is appended.

Therefore, the objective of the forester in formulating cutting plans is to partially cut the stand on a basis of individual tree classes, cutting the high-value species as lightly as possible, and low-value species as heavily as possible; and as economic and silvical conditions will permit.

It is further the objective of the forester to cut the stand in such a way that:

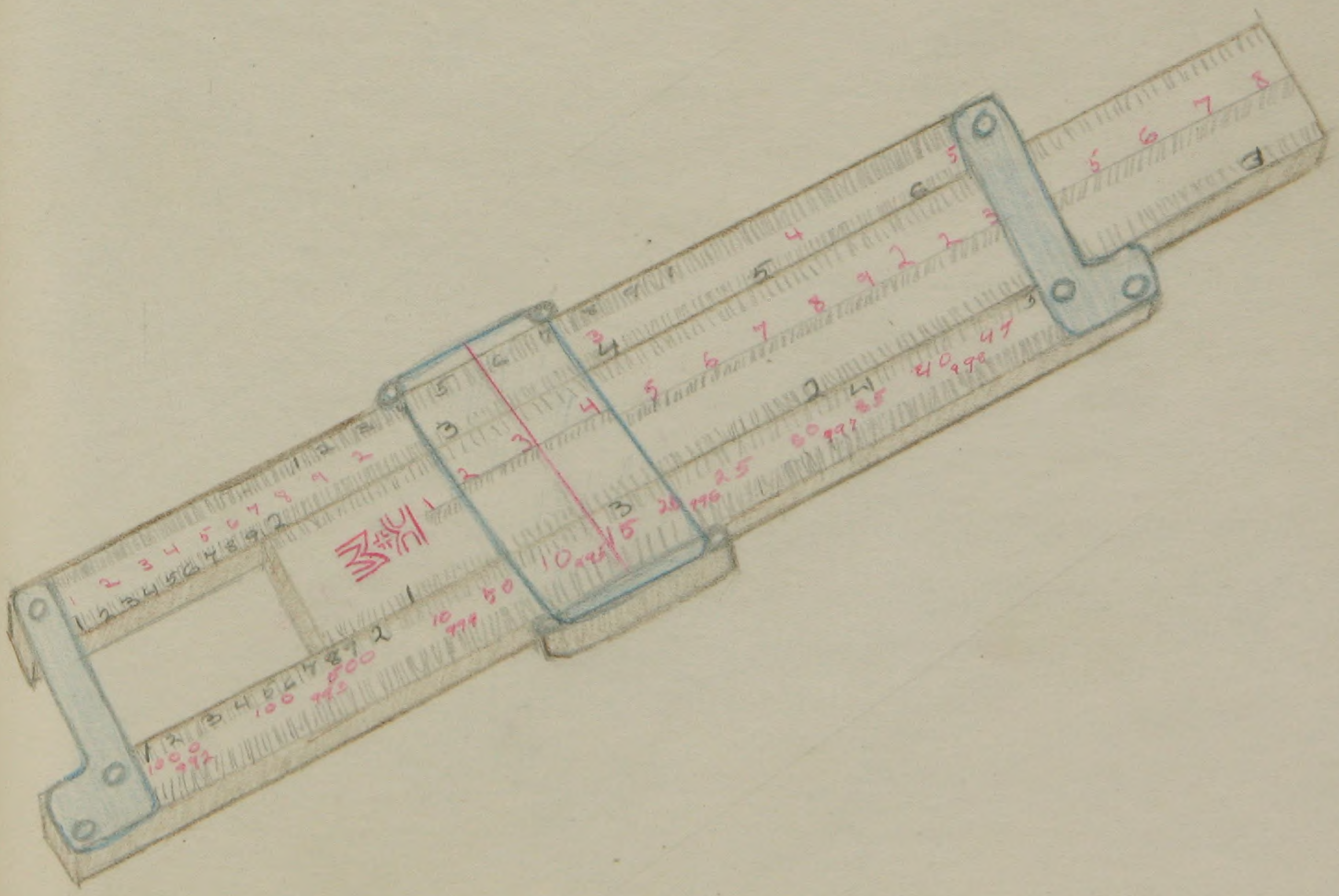
1. The portion of the stand cut is that part which can be cut at the lowest cost and/or greatest profit to the operator.

2. The quality of the residual stand is greater than the original, and the proportion of valuable species is higher.

3. The residual stand is of sufficient volume, density and size class distribution to guarantee a reasonable growth increment in the period up to the second cut, so that the operator may realize a reasonable profit on the investment in positive surplus stumpage which he has left in the residual stand.

4. The cut is of such a nature, that when applied over the entire area, it will result not only in sufficient logs of high enough quality and low enough cost of logging to run the operator's sawmill efficiently, and at a profit, but it must also be of such a nature as to perpetrate the forest as a balanced healthy biological entity which will be capable of providing further cuts to the owner.

THE MANAGEMENT PLAN



I N T R O D U C T I O N

PLANNING FOR SUSTAINED YIELD MANAGEMENT OF THE FOREST CROPLANDS OF THE COASTAL PINE SUBREGION OF TEHAMA COUNTY, CALIFORNIA.

The foregoing has served to acquaint the reader with the Coastal Pine Subregion forests of Tehama County, California.

The author has attempted to make a general survey of the forests describing their distribution, volume, species composition, growth peculiarities and ownership. The growing conditions of the area as affected by soil, climate, topography, existing timber stands, past utilization, and other factors has been examined and the silvicultural methods best adapted to the area have been described and the limitations of various cutting procedures have been assessed.

It remains, therefore, to examine the forest for sustained yield management, evaluating the various methods which may suggest themselves, and recommending that plan of action which, in the author's opinion, seems most suitable, taking everything into account; for the insurance of a permanent, productive forest, existing at a profit to the owner.

Too often foresters are inclined, when examining the potentialities of an area for sustained yield management, to consider the forest as an entity in itself whose only problems are of a biological nature. This approach, while necessary to the management plan from a technical point of view, is woefully inadequate when viewed by the business man who must consider the forest as a producer of a necessary raw material, and a producer at a profit. It is axiomatical to say that no matter how well a method of management may affect the biological perpetration of a forest, it is useless to the manager if it neglects to recognize the economic pressure of existing conditions.

Any forest represents an investment, which incurs expenses and is expected to produce a profit. Realizing the maximum profit, not only from the forest itself, but dependently also from the converting industry which depends on it as a source of raw materials, should be the first consideration of the forester.

With this objective in mind, we can examine the economic aspects of this particular situation.

As has been previously noted, prior to 1945 there was no commercial exploitation of this forest; the privately owned timber was held merely as an investment and the bulk of the publicly owned timber, although dedicated in the Mendocino National Forest, was not available for commercial exploitation because of its inaccessibility.

In 1945 and 1946 Mr. Harold Crane formed the Crane Mills to exploit the private timber which he had acquired and which represented about 75% of the total privately owned stands. The Crane Mills erected a sawmill in Paskenta with a capacity of about 60 M per 8 hour shift and began construction of a main haul road to the timber, which began about 15 miles from the mill at an elevation of about 3500 feet above it.

At this time there was at least an informal agreement between Crane Mills and the Forest Service to jointly dedicate both the National Forest timber and that timber owned by Crane to co-operative sustained yield management.

Since that time the Crane Mills have cut over 75 million board feet of timber, and while there has never been either a formal dedication of the area as a sustained yield working circle or an integrated plan of sustained yield management, both the publicly owned and Crane's timberland have been cut selectively with a view to eventually working out an integrated plan of management which will utilize the entire available area.

In view of the fact that the ownership of the timber land is largely in the hands of two organizations, Crane Mills and the Mendocino National Forest, the area is particularly adapted to co-operative management. Because 98% of the publicly owned timber is in the National Forest, and 75% of the privately owned timber is in Crane's hands, the complications of diversified ownership, varying use-dedication, and absentee ownership common to much of the western forests is avoided.

It is hoped that the remaining private ownership representing about 9% of the volume on the area will find it to their advantage to include their ownership in the management unit, or else sell out to Crane Mills, the only market for timber lands in the area. It might be well to add that the bulk of the 9% in other ownerships is held by the Setzer Forest Products Company of Sacremento, an organization also dedicated to sustained yield forest management.

At present, and in the forseeable near future, then; Crane

Mills sawmill at Paskenta is the only outlet and market for the forest products of the area. This condition is likely to continue inasmuch as Crane's road is the only road into the area, and while jointly constructed by the Forest Service and Crane Mills, it is controlled, for commercial purposes, by Crane Mills.

The prospect of pulp and veneer markets becoming available is discussed at greater length in the section on utilization, and the possible impact of this exigency on the economy of the operation is assessed.

It is, of course, true that trying to fit the production of a forest area to the requirements of a converting plant is putting the cart before the horse. However, this is often the precise situation, and when a large capital investment has been made without proper regard to the potentialities of the source of supply, some means is sought to reconcile this dilemma.

Market conditions as they exist today with high prices would seem to dictate as heavy a cut as is economically feasible in order to capitalize on the present demand for some of the inferior species which in the future it may become impossible to process at a profit. An immediate heavy cut would also facilitate an earlier amortization of the investment in sawmill and main haul road.

The sawmill has therefore been operating two shifts a day which, on the basis of 250 working days a year, amounts to a cut of about 30 million board feet per year. It is Mr. Crane's intention to eventually reduce the operation of the mill to one shift per day and therefore reduce the annual cut to 15 million board feet, for a period of time necessary to build up the growing stock and bring about an annual growth sufficient for a sustained annual yield in excess of 30 million board feet.

With an existing productive forest cropland of 127,490 acres, an annual growth in excess of 235 board feet per acre is necessary in order to insure a cut of 30 million board feet per year.

At the present time the available forest cropland is distributed as follows:

Class	Area in Acres	%	Average stand per acre
Old Growth	127,490	95	16,259 board feet
Restocking	1,430	1	1,474 board feet
Unstocked	5,320	4	0
Total	134,240	100	

This means that the forest is almost entirely mature and over-mature old growth and the area is probably not gaining in volume anymore, and in fact, the annual loss through mortality and decay may be exceeding the annual growth. Economic considerations would seem to dictate cutting over the area in as short a time as is financially possible so as to remove the over-mature timber before it is lost entirely through natural stand mortality. This has been the practice of the Crane Mills in the past three years.

The problem then is to cut the forest over in such a manner as to increase the growth from 0 to 235 board feet per acre per year, while at the same time insuring the maximum cut possible from the area in order to continue to operate the mill at a profit.

If an operator leaves timber on the ground now merely because he has been convinced that he will incur a loss by converting it into lumber and then, because he has a financial stake in the land is induced to protect the area, he will, it is true, be able to make a second cut. However, it is unlikely that this second cut will be available in time or sufficient in amount to keep his manufacturing plant and equipment operating at capacity; and it is in this fact that the danger lies. The second cut must be planned for now, as must subsequent future cuts, and the conversion capacity of the operation brought into line with the productive capacity of the area.

It is difficult, if not impossible, for any timber land operator to forecast the long range demand for forest products. As competition increases, new products are found, forest resources in other regions are increased or depleted, new demands for cellulose in varying forms are developed; when any of a host of foreseeable and unknown factors come into existence, the value of any particular stand of timber will fluctuate, regardless of the plan of management.

The successful forester, like the successful business man, must be ready to shift his conception of the forest as a renewable natural resource in order to adapt to changing markets and methods of utilization. The question is further complicated by the fact that owing to the peculiarities of his working medium, the growing forest, the forester must be prepared to plan and formulate policy for a period further in the future than is usually required in other businesses.

The most valuable forest 100 years from now is problematical. Forest products may eventually be sold by the pound, or by the chemical content per cubic unit, or by the percentage of digestible food content per unit! Sawlogs may become an obsolete primary manufacturing unit and the board foot unit of measurement inadequate for the measure of new products.

The author has mentioned these hypothetical exigencies merely to point out the foolishness of slavishly following one particular conception of the forest's future. The prediction of the stand of timber on a particular acre in 100 years, and its value at that time, reduced to the present, is impossible. It would mean forecasting, among many items of subtler effect; the fluctuation of interest rates, the cost and effectiveness of protection, the future market for a raw material as it exists today, the increasing use or abandonment of particular products, and financial pressure or relative liquidity of the individual operator. It means in addition, forecasting government policies, particularly taxation and regulation, a matter of year by year and month by month difficulty.

The most astute business men would find difficulty in forecasting the effect of these factors from year to year, and yet many foresters naively presume to do just that, and to it do for the next 100 years, or more, if called upon!

Before the reader is overwhelmed by the difficulties of long range forest management, it is necessary to define the use and intention of any management plan.

In order to perpetrate his organization, every manager must assess its future methods and means of operation. The past is the only basis upon which one can appraise the future. Economic cycles have a habit of re-occurring; and an honest, able, and justifiable assessment of conditions in the past as they are likely to occur or appear in the future is very necessary. A manager must have in his hands the necessary tools with which to make the predictions which are obligatory to the successful continuance of his business.

In the operation of a forest products industry dependent upon the sustained yield of a forest, an accurate forest management plan is just such a tool. The management plan, then, is not an end in itself, but is useful only as a guide in assessing the future as accurately as possible.

As conditions change, the forester must adapt the management plan to changing demands upon it. The management plan for the area under examination in this report is intended to value the productive capacity of the forest under different methods of treatment and to predict, insofar as is possible, the future production of the forest.

T H E

M A N A G E M E N T

P L A N

THE MANAGEMENT PLAN

Growth on and cut from the forest have been predicted for four different cutting cycles; namely 15, 20, 25, and 30 years. The cut over the cycle and the cut per acre necessary over each cycle are as follows:

15 Year Cutting Cycle

The area is predicted for two complete cuts to furnish 30,000,000 board feet per year. At the start of the third cutting cycle, the cut is reduced to 15,000,000 board feet per year, and this cut is maintained until the average growth per acre reaches 235 board feet per acre per year, a period of 30 years. The stand per acre, then, is predicted over a period of 60 years.

20 Year Cutting Cycle

The area is predicted for two complete cuts to furnish 30,000,000 board feet per year. At the start of the third cutting cycle, the cut is reduced to 15,000,000 board feet per year, and this cut is maintained until the average growth per acre reaches 235 board feet per acre per year, a period of 39 years. The stand per acre, then, is predicted over a period of 80 years.

25 Year Cutting Cycle

The area is predicted for two complete cuts to furnish 30,000,000 board feet per year. At the start of the third cutting cycle, the cut is reduced to 15,000,000 board feet per year. This cut is predicted through the third cutting cycle. At the end of the third cutting cycle, after a period of 75 years, the average growth per acre per year has reached only 153 board feet, 65% of the necessary 235 board feet. The prediction is carried no further because of the technical difficulty of predicting growth over periods longer than 75 or 80 years. It can be assumed, however, that at least three cutting cycles at 15,000,000 board feet per year would be required to build growth up to an average of 235 board feet per acre per year. This would mean a period, from the time of the first cut, in excess of 125 years.

30 Year Cutting Cycle

The stand per acre resulting from a 30 year cutting cycle is predicted for one cut, a period of 30 years. This is done to show the effect of this and heavier cuts upon the residual stand. With cutting cycles greater than 25 years the period of time necessary to reach an average growth of 235 board feet per acre per year is a matter of conjecture, but would certainly be in excess of 150 years.

CUT PER ACRE

The cut per acre for each length cutting cycle and for subsequent cuts is as follows:

Cutting Cycle	First Cut Volume	First Cut %	Second Cut Volume	Second Cut %	Third Cut Volume	Third Cut %	Fourth Cut Volume	Fourth Cut %
15	3,525	21.7	3,525	25.3	1,762	13.7	1,762	12.8
20	4,700	28.9	4,700	34.6	2,350	20.1	2,350	17.7
25	5,875	35.2	5,875	45.4	2,938	29.5		
30	7,050	43.4						

CUT PER YEAR

The average cut per year over the period predicted would then be as follows:

Cutting Cycle	Total Period	Total Cut	Average Cut
15	60	1,350,000,000	22,500,000
20	80	1,800,000,000	22,500,000
25	75	1,875,000,000	23,666,667
30	30	900,000,000	30,000,000

GROWTH PREDICTION

The method of predicting growth per acre and subsequent yield is taken from United States Department of Agriculture Technical Bulletin Number 407 entitled: Growth in Selectively Cut Ponderosa Pine Forests of the Pacific Northwest. By Walter H. Meyer.

While not strictly applicable to the area under discussion this is the best available analysis of yields for this general area. The methods adapted from this bulletin are summarized as follows.

The method used is to take board foot volume growth from a table of residual stands after cutting, carried forward for a particular number of years. The values found by this method are then adjusted by considerations of site quality, stand structure and estimated mortality. Preliminary values are taken from the following table, which has been adjusted to Site 3 as previously described, the site peculiar to almost the entire forest.

BOARD-FOOT VOLUME GROWTH, SCRIBNER RULE, IN SELECTIVELY CUT STANDS OF PONDEROSA PINE, ALL TREES 11.6 INCHES OR MORE IN DIAMETER AT BREAST HEIGHT INCLUDED.

Volume of reserved stand per acre

At time of cutting (board feet)	After an interval of 10 years	20 years	30 years
1,000	1,400	1,800	2,300
2,000	2,700	3,300	4,000
3,000	3,900	4,500	5,400
4,000	4,900	5,700	6,700
5,000	6,000	6,800	7,800
6,000	7,000	7,900	9,000
7,000	8,000	9,000	10,200
8,000	9,100	10,200	11,400
9,000	10,200	11,300	12,700
10,000	11,300	12,500	14,000
11,000	12,300	13,600	15,100
12,000	13,300	14,700	16,300
13,000	14,300	15,800	17,600
14,000	15,400	17,000	19,000
15,000	16,500	18,300	20,300

CORRECTION FOR EFFECT OF STAND STRUCTURE, MEASURED BY THE PERCENTAGE OF BASAL AREA IN TREE CLASSES 1, 2, AND 3 AS DEFINED BY DUNNING'S SYSTEM OF TREE CLASSIFICATION

Percentage of basal area in tree class 3	Correction percentage for stand structure when the percentage of basal area in tree classes 1 and 2 is -					
	0	10	20	30	40	50
0	62	69	77	85	93	101
10	67	75	83	90	98	106
20	72	80	88	96	103	111
30	78	85	93	101	109	117
40	83	91	98	106	114	122
50	88	96	104	112	119	127

ADJUSTING FOR MORTALITY

Pending the time when average mortality rates over long periods will be definitely determined, a mortality correction of 15 percent of the total gross annual increment has been tentatively adopted for the first two cutting cycles in all cases. Beginning with the third cutting cycle the correction for mortality has been reduced inasmuch as experience has shown that the greatest mortality occurs after the first cut in a virgin timber stand, and decreases with subsequent cutting.

An application of these methods of growth prediction to the cutting cycles examined in this report are as follows.

15 YEAR CUTTING CYCLE

	First Cycle	Second Cycle	Third Cycle	Fourth Cycle
Volume after cutting	12,735	10,440	10,943	11,971
Gross yield in 15 years	14,772	12,362	12,890	13,970
Structure	35-20	40-30	30-40	30-45
Correction for structure	.96	1.06	1.09	1.13
Corrected yield	14,181	13,104	14,050	15,786
Total gross increment	1,446	2,664	3,107	3,815
Mortality percent	15	15	10	8
Reduced by mortality	1,229	2,264	2,796	3,510
Average growth per acre per year	82	151	186	234

20 YEAR CUTTING CYCLE

Volume after cutting	11,560	8,880	9,330	10,900
Gross yield in 20 years	14,216	11,168	11,696	13,490
Structure	40-20	30-40	30-50	20-60
Correction for structure	.98	1.09	1.17	1.19
Corrected yield	13,932	12,173	13,684	16,053
Total gross increment	2,372	3,293	4,354	5,153
Mortality percent	15	15	10	8
Reduced by mortality	2,016	2,799	3,919	4,741
Average growth per acre per year	101	140	196	237

25 YEAR CUTTING CYCLE

	First Cycle	Second Cycle	Third Cycle
Volume after cutting	10,385	7,060	7,022
Gross yield in 25 years	13,674	9,672	9,626
Structure	40-20	30-40	30-50
Correction for structure	.98	1.09	1.17
Corrected yield	13,400	10,542	11,262
Total gross increment	3,015	3,482	4,240
Mortality percent	15	15	10
Reduced by mortality	2,563	2,960	3,816
Average growth per acre per year	102	118	153

30 YEAR CUTTING CYCLE

Volume after cutting	9,210
Gross yield in 30 years	12,973
Structure	30-30
Correction for structure	1.01
Corrected yield	13,103
Total gross increment	3,893
Mortality percent	15
Reduced by mortality	3,309
Average growth per acre per year	110

This results in the following average stands per acre by the four different cutting cycles used, for each year from 1945 forward, as far as results have been predicted.

AVERAGE STAND PER ACRE

Cutting Cycle

	15 yrs.	20 yrs.	25 yrs.	30 yrs.
1945	16,260	16,260	16,260	16,260
46	16,025	16,025	16,025	16,025
47	15,795	15,795	15,794	15,794
48	15,571	15,570	15,567	15,566
49	15,353	15,350	15,344	15,342
50	15,140	15,135	15,126	15,122
51	14,932	14,926	14,911	14,905
52	14,730	14,721	14,701	14,692
53	14,533	14,521	14,494	14,483
54	14,342	14,327	14,292	14,277
55	14,156	14,137	14,094	14,075
56	13,976	13,953	13,899	13,877
57	13,801	13,773	13,709	13,682
58	13,631	13,599	13,523	13,491
59	13,467	13,430	13,341	13,304
60	13,309	13,265	13,163	13,120
61	13,156	13,106	12,990	12,940
62	13,008	12,952	12,820	12,764
63	12,864	12,803	12,654	12,591
64	12,723	12,659	12,493	12,422
65	12,590	12,520	12,335	12,257
66	12,460	12,386	12,182	12,095
67	12,335	12,253	12,032	11,937
68	12,214	12,123	11,887	11,783
69	12,098	11,995	11,746	11,632
70	11,986	11,869	11,609	11,485
71	11,879	11,745	11,476	11,342
72	11,777	11,622	11,344	11,202
73	11,679	11,502	11,212	11,066
74	11,585	11,384	11,081	10,934
75	11,497	11,267	10,950	10,805
76	11,530	11,153	10,821	10,680
77	11,566	11,040	10,691	
78	11,604	10,930	10,563	
79	11,645	10,820	10,435	
80	11,688	10,714	10,307	
81	11,733	10,610	10,181	
82	11,781	10,507	10,055	
83	11,830	10,406	9,930	
84	11,833	10,307	9,805	
85	11,937	10,210	9,681	
86	11,994	10,232	9,558	
87	12,053	10,258	9,435	
88	12,115	10,286	9,313	
89	12,139	10,317	9,171	
90	12,245	10,315	9,051	
91	12,313	10,387	8,930	
92	12,385	10,426	8,811	
93	12,460	10,468	8,692	

AVERAGE STAND PER ACRE

Cutting Cycle

	15 yrs.	20 yrs.	25 yrs.	30 yrs.
1994	12,538	10,513	8,574	
95	12,618	10,561	8,456	
96	12,702	10,612	8,457	
97	12,790	10,665	8,458	
98	12,881	10,721	8,462	
99	12,975	10,780	8,466	
2000	13,072	10,842	8,472	
01	13,173	10,906	8,480	
02	13,277	10,973	8,489	
03	13,383	11,043	8,499	
04	13,494	11,116	8,511	
05	13,607	11,142	8,524	
06	13,723	11,270	8,538	
07		11,351	8,554	
08		11,433	8,571	
09		11,518	8,590	
10		11,605	8,610	
11		11,694	8,632	
12		11,784	8,655	
13		11,877	8,679	
14		11,972	8,705	
15		12,069	8,736	
16		12,168	8,760	
17		12,269	8,790	
18		12,372	8,821	
19		12,478	8,854	
20		12,585	8,888	
21		12,694	8,924	
22		12,805		
23		12,919		
24		13,034		
25		13,152		
26		13,271		

The limiting factor in the choice of a cutting cycle is the speed with which the road system can be extended. The rugged topography and resulting high cost of road construction limits the amount of main haul and skid roads which can be constructed in any one year.

A general examination of the area and an assessment of the present costs and speed of road construction would seem to indicate that a minimum of 15 years would be required in order to build an adequate road system over the area.

All things considered, the 20 year cutting cycle would seem to be the best to all intents and purposes.

In summary, a few things might be noted. According to the best available yield tables, these lands are capable of producing in excess of 45,000 board feet per acre for a managed rotation of 150 years. This would be increased as it becomes financially feasible to remove thinnings from the smaller trees as the forest is cut. In any event, a minimum growth of 300 board feet per acre per year can be expected when the forest reaches full stocking under management. This would mean a sustained annual production of over 38,000,000 board feet, a goal that is the eventual hope of the forester in the management of this area.

A P P E N D I X

BIBLIOGRAPHY

Baker, F. S. 1922. Western Yellow Pine in Southern Idaho. Mimeographed pub. U. S. Forest Service District 4.

______ 1929. Effect of Excessively High Temeratures on Coniferous Reproduction. Jour. For. 27:949-957.

______ 1945. Forest Cover Types of Western North America. Society of American Foresters.

Bates, C. G. and Roeser, J., Jr. 1928. Light Intensities Required for Growth of Coniferous Seedlings. Amer. Jour. Bot. 15:185-194.

Behre, C. E. 1928. Preliminary Normal Yield Tables for Second-growth Western Yellow Pine in Northern Idaho and Adjacent Areas. Jour. Agr. Res. 37:379-397.

Briegleb, P. A. 1947. Use of Yield Tables for Forest Survey Growth Estimates. Unpublished manuscript.

Brown, N. C. 1913. Management of Western White Pine in Idaho. Proc. Soc. Amer. For. 8:327-332.

Brundage, M. R. Krueger, M. E., and Dunning, D. 1933. The Economic Significance of Tree Size in Western Sierra Lumbering. Cal. Agr. Exp. Sta. Bull. 549.

Chandler, B. A. 1916. Notes on a Method of Studying Current Growth Percent. For. Quart. 14:453-460.

Chapman, H. H. 1912. A Method of Investigating Yield per Acre in Many Aged Stands. For. Quart. 10:458-469.

______ 1931. Forest Management. Albany, N. Y.

Chapline, W. R. Cooperrider, C. K., 1941. Climate and Grazing. Yrbk. of Agr. Separate No. 1811.

Clapp, E. H., 1912. Silvicultural Systems for Western Yellow Pine. Proc. Soc. Amer. For. 7:168-176.

Dunning, D. 1923. Some Results of Cutting in the Sierra Forests of California. U. S. Dept. Agr. Dept. Bull. 1176.

——— 1928. A Tree Classification for the Selection Forests of the Sierra Nevada. Jour. Agr. Res. 36:755-771.

——— 1942. A Site Classification for the Mixed-Conifer Selection Forests of the Sierra Nevada. Cal. For. Expt. Sta. Research Note No. 28.

——— and Reineke, L. H., 1933. Preliminary Yield Tables for Second Growth Stands in the California Pine Region. U. S. Dept. Agr. Tech. Bull. 354.

Hall, R. C. 1935. The Forest-Tax Problem and its Solution Summarized. U. S. Dept. Agr. Circular 358.

Hanzlik, E. J. Determination of the Annual Cut on a Sustained Yield Basis for Virgin American Forests. Unpublished manuscript.

Hoffman, J. V. 1924. The Natural Regeneration of Douglas Fir in the Pacific Northwest. U. S. Dept. Agr. Dept. Bull. 1200.

Isaac, L. A. 1938. Factors Affecting Establishment of Douglas Fir Seedlings. U. S. Dept. Agr. Circ. 486.

Jardine, J. T. and Anderson, M., 1919. Range Management on the National Forests. U. S. Dept. Agr. Bull. 790.

Jepson, W. L. 1923-25. Flora of California. Berkeley, California.

Kirkland, B. P. and Brandstrom, A. J. F., 1936. Selective Timber Management in the Douglas Fir Region. Washington, D. C.

Korstian, C. F. and Baker, F. S., 1922. Is Douglas Fir Replacing Western Yellow Pine in Central Idaho? Jour. For. 20:755-764.

Krauch, H. 1924. Acceleration of Growth in Western Yellow Pine Stands After Cutting. Jour. For. 22:39-42.

Krauch, H. 1930. Mortality in Cut-over Stands of Western Yellow Pine. Jour. For. 28:1085-1097.

Kuhn, R. L. 1948. Preliminary and Final County Budget County of Tehama, State of California, for the Fiscal Year Ending June 30, 1949. Red Bluff, California.

Larsen, L. T. and Woodbury, T. D., 1916. Sugar Pine. U. S. Dept. Agr. Bull. 426.

McArdle, R. E. and Meyer, W. H., 1930. The Yield of Douglas Fir in the Pacific Northwest. U. S. Dept. Agr. Tech. Bull. 201.

Meyer, W. H. 1930. A Study of the Relation Between Actual and Normal Yields of Immature Douglas Fir Forests. Jour. Agr. Res. 41:635-665.

——— 1934. Growth in Selectively Cut Ponderosa Pine Forests of the Pacific Northwest. U. S. Dept. Agr. Tech. Bull. 407.

——— 1938. Yield of Even-Aged Stands of Ponderosa Pine. U. S. Dept. Agr. Tech. Bull. 630.

Mitchell, J. A. 1918. Incense Cedar. U. S. Dept. Agr. Bull. 604.

Pearson, G. A. 1912. The Influence of Age and Condition of the Tree Upon Seed Production in Western Yellow Pine. U. S. For. Serv. Cir. 196.

——— 1931. Recovery of Western Yellow Pine Seedlings from Injury by Grazing Animals. Jour. For. 29:876-894.

Perry, W. J. 1921. Yellow Pine Reproduction. Jour. For. 19:622-631.

——— 1929. Damage to Western Yellow Pine Reproduction Under Various Logging Methods. Jour. For. 27:500-506.

Roeser, J. 1924. A Study of Douglas Fir Reproduction Under Various Cutting Methods. Jour. Agr. Res. 28:1233-1242.

Schumacher, F.X. 1926. Yield, Stand and Volume Tables for White Fir in the California Pine Region. Calif. Agr. Exp. Sta. Bull. 407.

Schumacher, F. X. 1928. Yield, Stand and Volume Tables for Red Fir in California. Calif. Agr. Exp. Sta. Bull. 456.

______ 1930. Yield, Stand and Volume Tables for Douglas Fir in California. Calif. Agr. Exp. Sta. Bull. 491.

______ 1932. Effect of Partial Cutting in the Virgin Stand Upon the Growth and Taper of Western Yellow Pine. Calif. Agr. Exp. Sta. Bull. 540.

Show, S. B. 1925. Yield Capacities of the Pure Yellow Pine Type on the East Slope of the Sierra Nevada Mountains in California. Jour. Agr. Res. 31:1121-1135.

______ 1926. Timber Growing and Logging Practice in the California Pine Region. U. S. Dept. Agr. Dept. Bull. 1402.

______ and Kotok, E. I., 1937. Principles of Forest Fire Detection on the National Forests of Northern California. U. S. Dept. Agr. Tech. Bull. 574.

Sparhawk, W. N. 1918. Effect of Grazing Upon Western Yellow Pine Reproduction in Central Idaho. U. S. Dept. Agr. Bull. 738.

Sproat, W. J. 1930. The Natural Reproduction of Western Yellow Pine. Jour. For. 28:334-337.

Weidman, R. H. 1921. Forest Succession as a Basis of the Silviculture of Western Yellow Pine. Jour. For. 19:877-885.

Wieslander, A. E. and Jensen, H. A., 1946. Forest Areas, Timber Volumes and Vegetation Types in California. Calif. For. and Range Exp. Sta. For. Survey Release 4.

Woodbury, T. D. 1930. Development of Silvicultural Practices in the California National Forests. Jour. For. 28:693-700.

Anonymous 1939. The Principal Laws Relating to the Establishment and Administration of the National Forests and to Other Forest Service Activities. U. S. Dept. Agr. Miscell. Public. 135.

Anonymous 1925. Volume Tables for the Important Timber Trees of the United States. Part I Western Species. U. S. Dept. Agr.

1945. Forest Practice Rules for California. Pub. by Western Pine Association, Portland, Oregon.

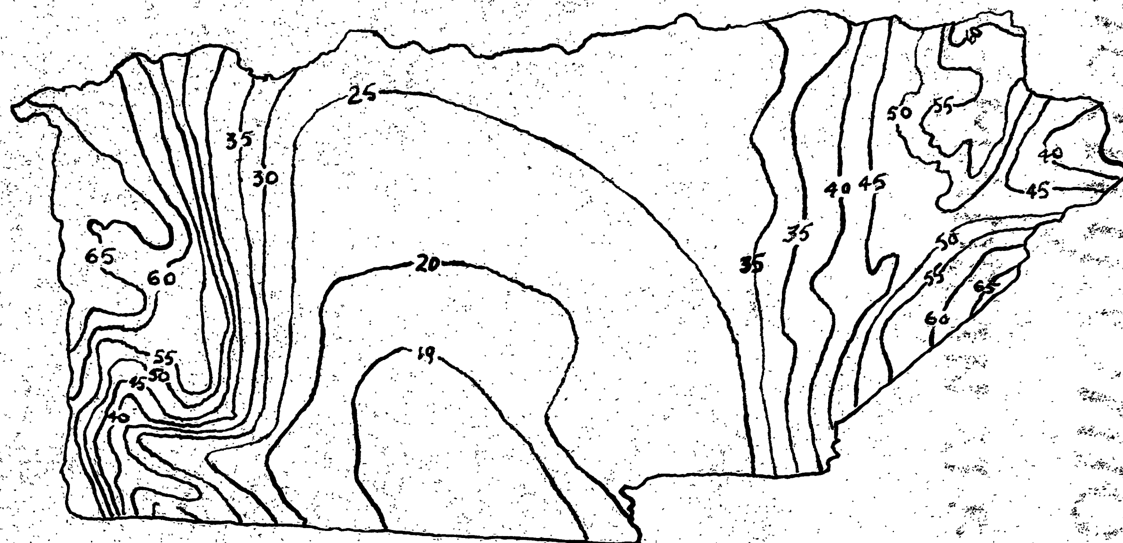
MAP SUPPLEMENT I

TEHAMA COUNTY
CALIFORNIA

Vegetation Type Map

MAP SUPPLEMENT II

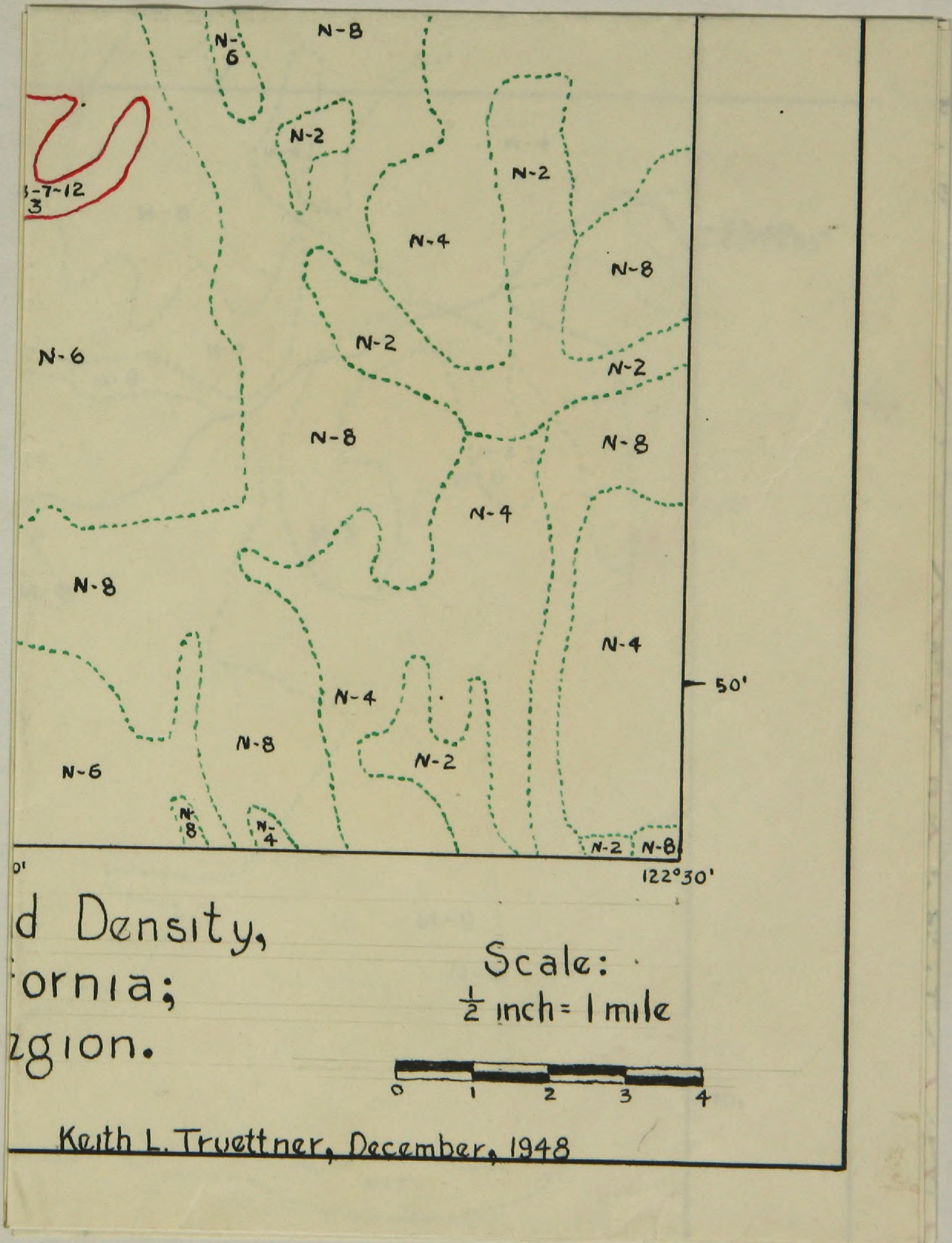
TEHAMA COUNTY
CALIFORNIA

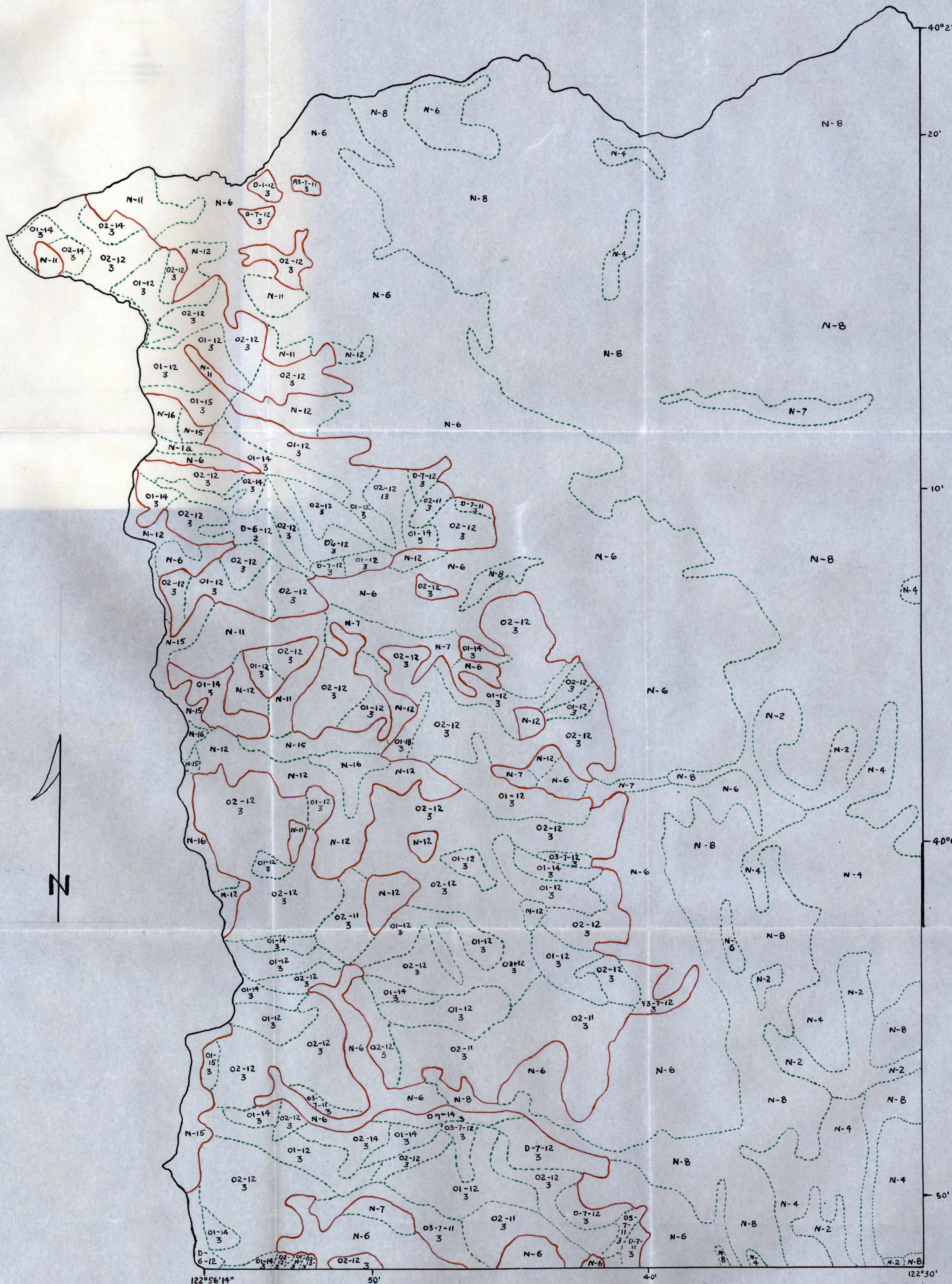


Normal Seasonal Isohyetal Map

Figures in Inches of Average Rainfall

MAP SUPPLEMENT III





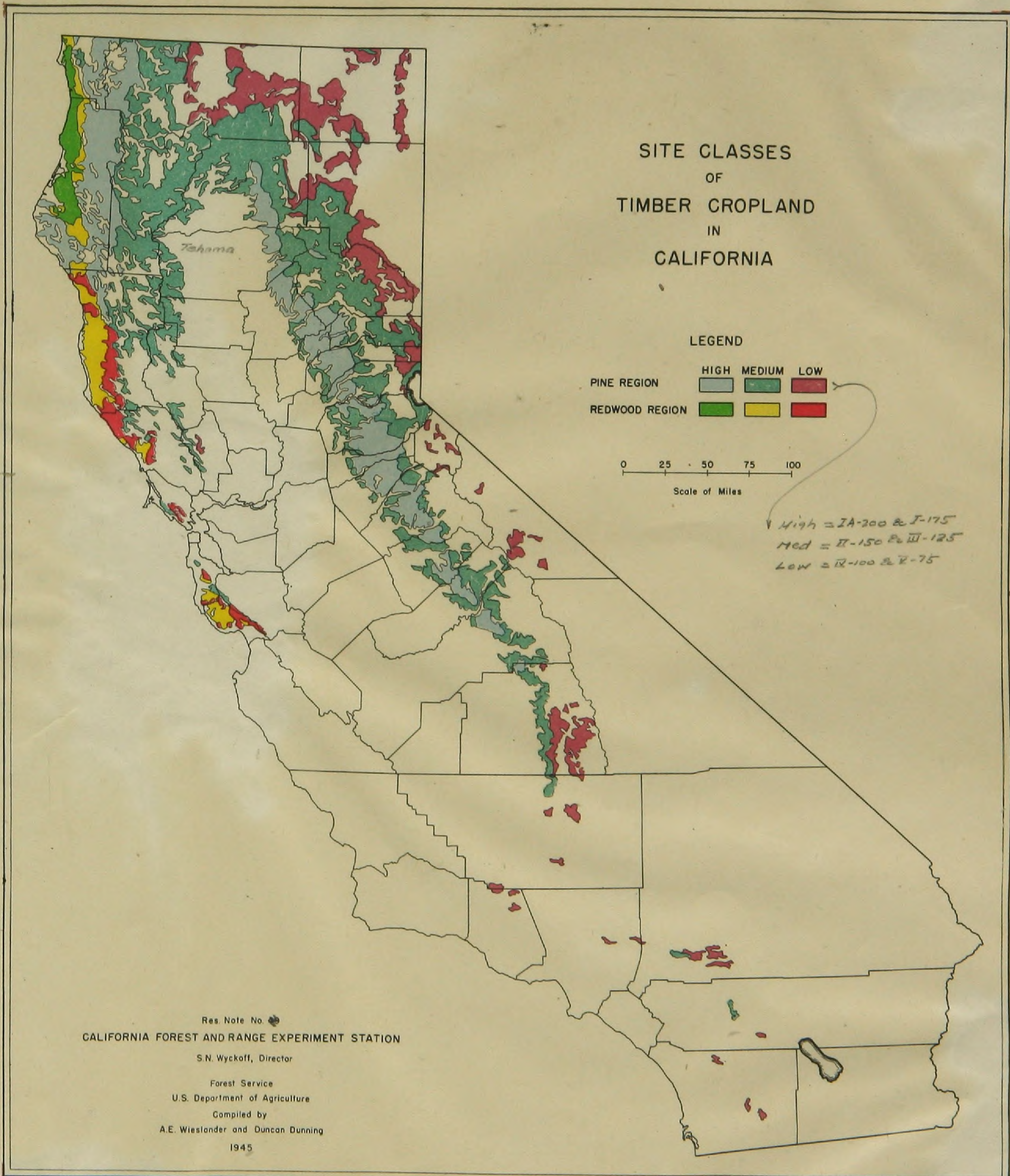
Prepared From Aerial Photographs and Forest Survey and National Forest Vegetation Maps

Vegetation Class, Forest Cropland Type, Stand Density, and Site Class Map. Tehama County, California; Pine Region – Coastal Mountains Sub-Region.

Scale: ½ inch = 1 mile

0 1 2 3 4

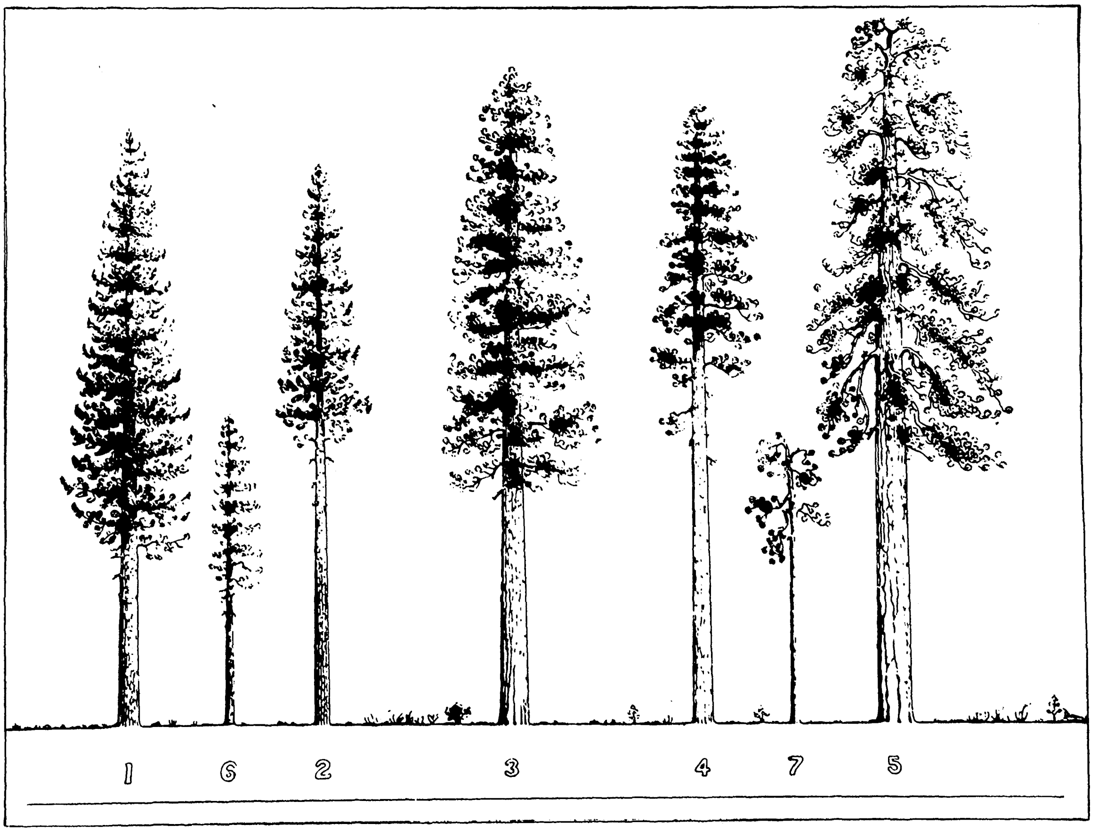
Keith L. Truettner, December, 1948

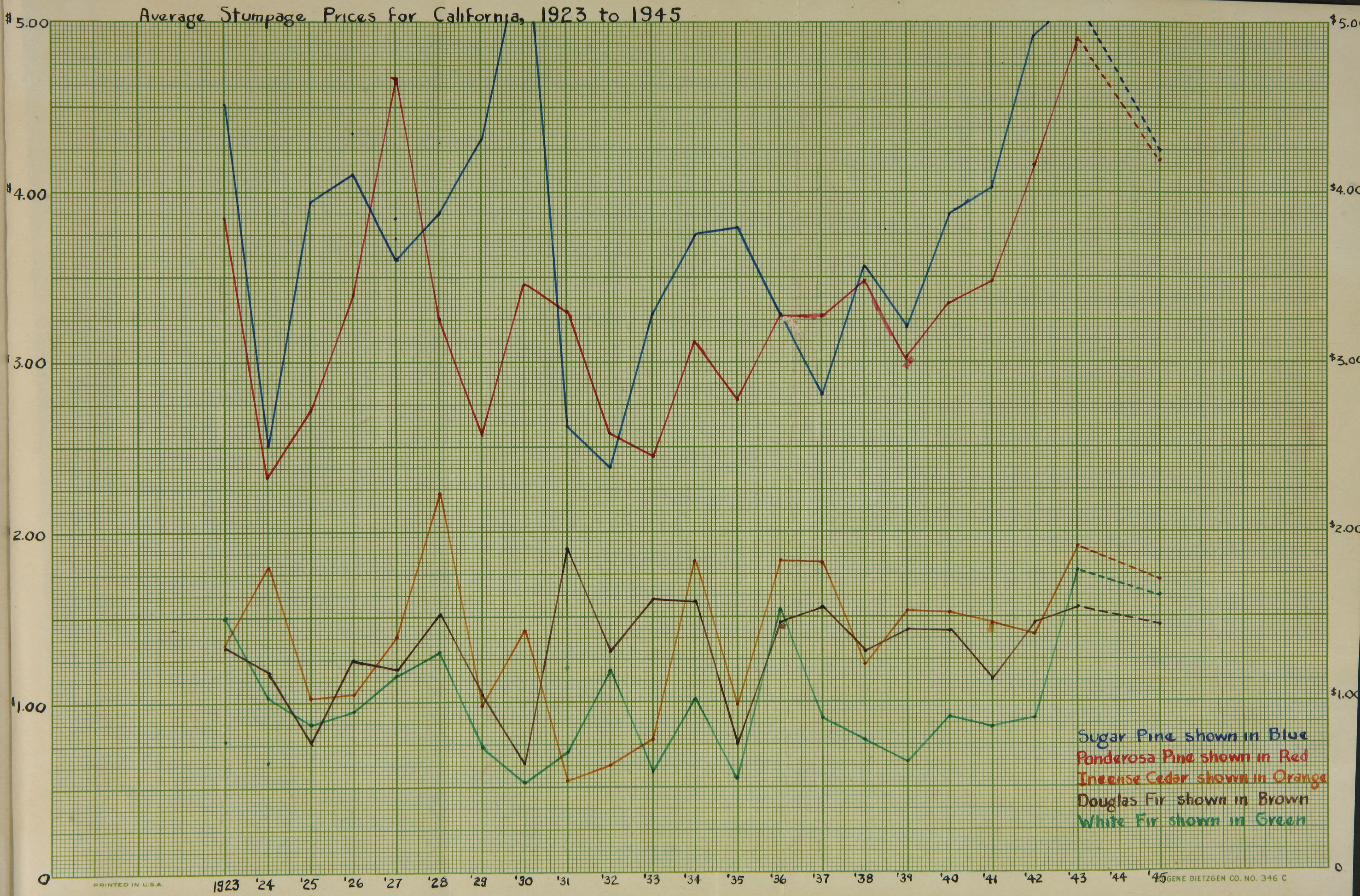


SITE CLASSES
OF
TIMBER CROPLAND
IN
CALIFORNIA
Tehama
LEGEND
HIGH MEDIUM LOW
PINE REGION
REDWOOD REGION
0 25 50 75 100
Scale of Miles
High = IA-200 & I-175
Med = II-150 & III-125
Low = IV-100 & V-75
Res. Note No.
CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
S.N. Wyckoff, Director
Forest Service
U.S. Department of Agriculture
Compiled by
A.E. Wieslander and Duncan Dunning
1945

DESCRIPTION OF DUNNING'S TREE CLASSES

Item	1	2	3	4	5	6	7
Age Classes (Approximate)	Immature-Thrifty (60-150 Yrs)	Immature-Thrifty (60-150 Yrs)	Thrifty-mature or mature (150-300 Yrs)	Mature (150-300 Yrs)	Over-Mature (Over 300 Years)	Immature (60 - 150 Yrs)	Mature and Over-mature (Over 150 Yrs)
Position	Isolated or Dominant	Usually Co-dominant	Isolated or Dominant	Usually Co-dominant	Isolated or Dominant	Intermediate or Suppressed	Intermediate or Suppressed
Crown lengths (Approximate)	65% or more	Up to 65%	65% or more	Up to 65%	Any length	Usually short	Usually short
Crown width	Average or wider	Less than Average	Average or wider	Less than Average	Any width	Any width	Any width
Seed bearing capacity	Fair	Poor	Very good	Greatest insect risk. Fair to Good.	Very good	Very poor	Poor
Form of top	Pointed	Pointed	Rounded	Rounded	Flattened	Pointed Rounded	Flat
Vigor	Good	Good - Moderate	Moderate	Moderate - Poor	Poor	Moderate - Poor	Poor
Diameter (Approximate)	Rarely over 30 inches.	Up to 24"	18" to 40"	Except for the small, poorly developed crown, smaller size, and lower vigor, similar to Class No. 3.	Largest Trees	12" to 16"	Rarely over 18".
Bark	Dark; Ridges or small plates.	Dark; Ridges or small plates	Light brown or yellow; mod. large plates		Light yellow; wide, long smooth plates	Dark and rough ridged	Light yellow, thin and flat
Foliage	Rich green, dense, needles long and coarse	Rich green, mod. dense, needles long and coarse	Lighter green than #1, mod. dense; shorter than #1		Pale green, thin, tufty on ends of twigs.	Not so dense as #1 and #2	Very thin
Annual whorls	Distinct except on lower crown	Less distinct than #1	Nodes indistinct, branches horizontal or drooping		Branches drooping, gnarled and twisted, top flat	Internodes short	Indistinct. Branches few, and gnarled and drooping
Risk	Good	Good	Fair to good	Poor to fair	Poor	Fair to good	Poor




Average Stumpage Prices for California, 1923 to 1945
$5.00
$4.00
$3.00
$2.00
$1.00
0
1923
'24
'25
'26
'27
'28
'29
'30
'31
'32
'33
'34
'35
'36
'37
'38
'39
'40
'41
'42
'43
'44
'45
Sugar Pine shown in Blue
Ponderosa Pine shown in Red
Incense Cedar shown in Orange
Douglas Fir shown in Brown
White Fir shown in Green
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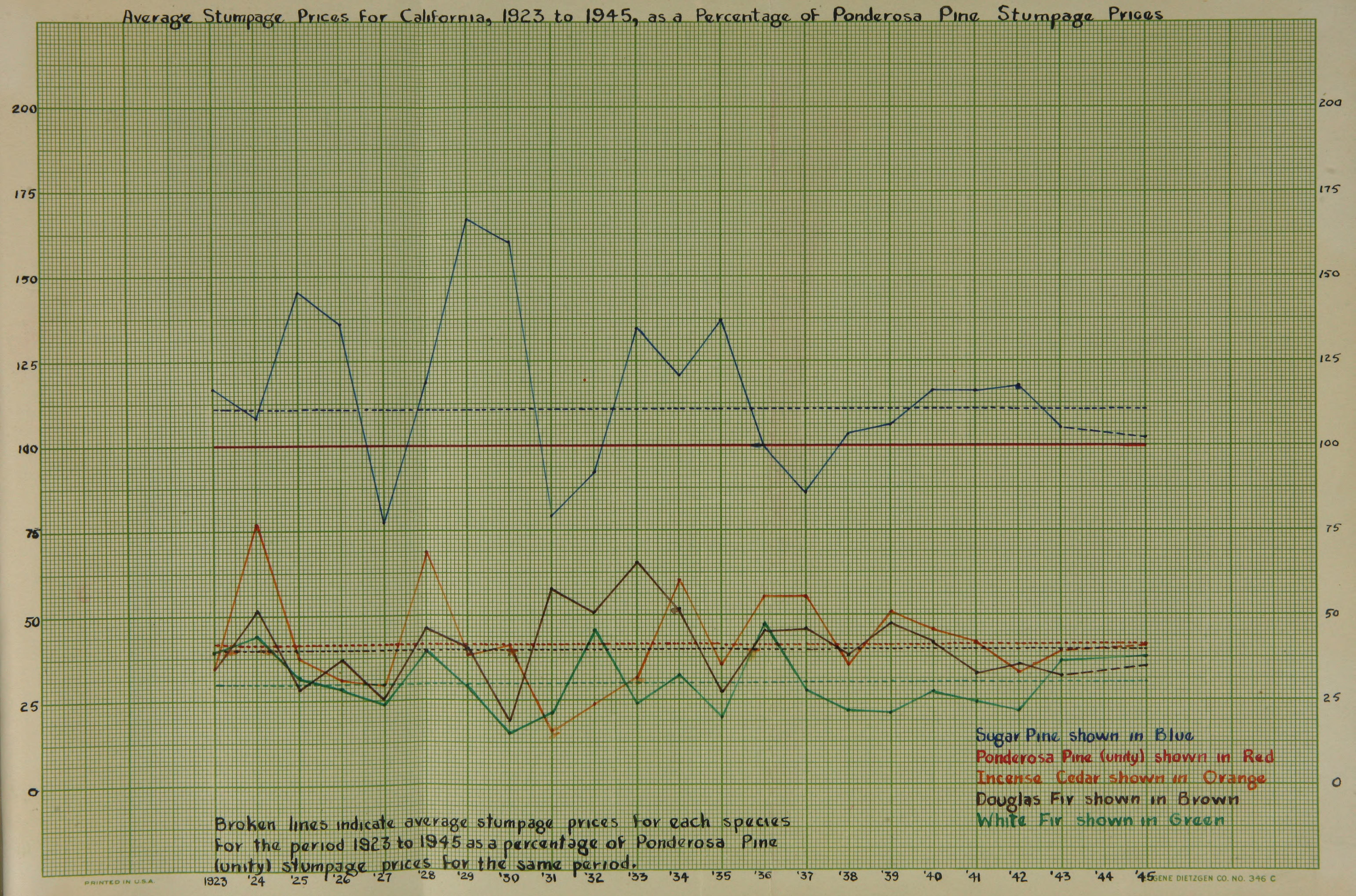
EUGENE DIETZGEN CO. NO. 346 C


Average Stumpage Prices for California, 1923 to 1945, as a Percentage of Ponderosa Pine Stumpage Prices
200
175
150
125
100
75
50
25
0
1923
'24
'25
'26
'27
'28
'29
'30
'31
'32
'33
'34
'35
'36
'37
'38
'39
'40
'41
'42
'43
'44
'45
Sugar Pine shown in Blue
Ponderosa Pine (unity) shown in Red
Incense Cedar shown in Orange
Douglas Fir shown in Brown
White Fir shown in Green
Broken lines indicate average stumpage prices for each species for the period 1923 to 1945 as a percentage of Ponderosa Pine (unity) stumpage prices for the same period.
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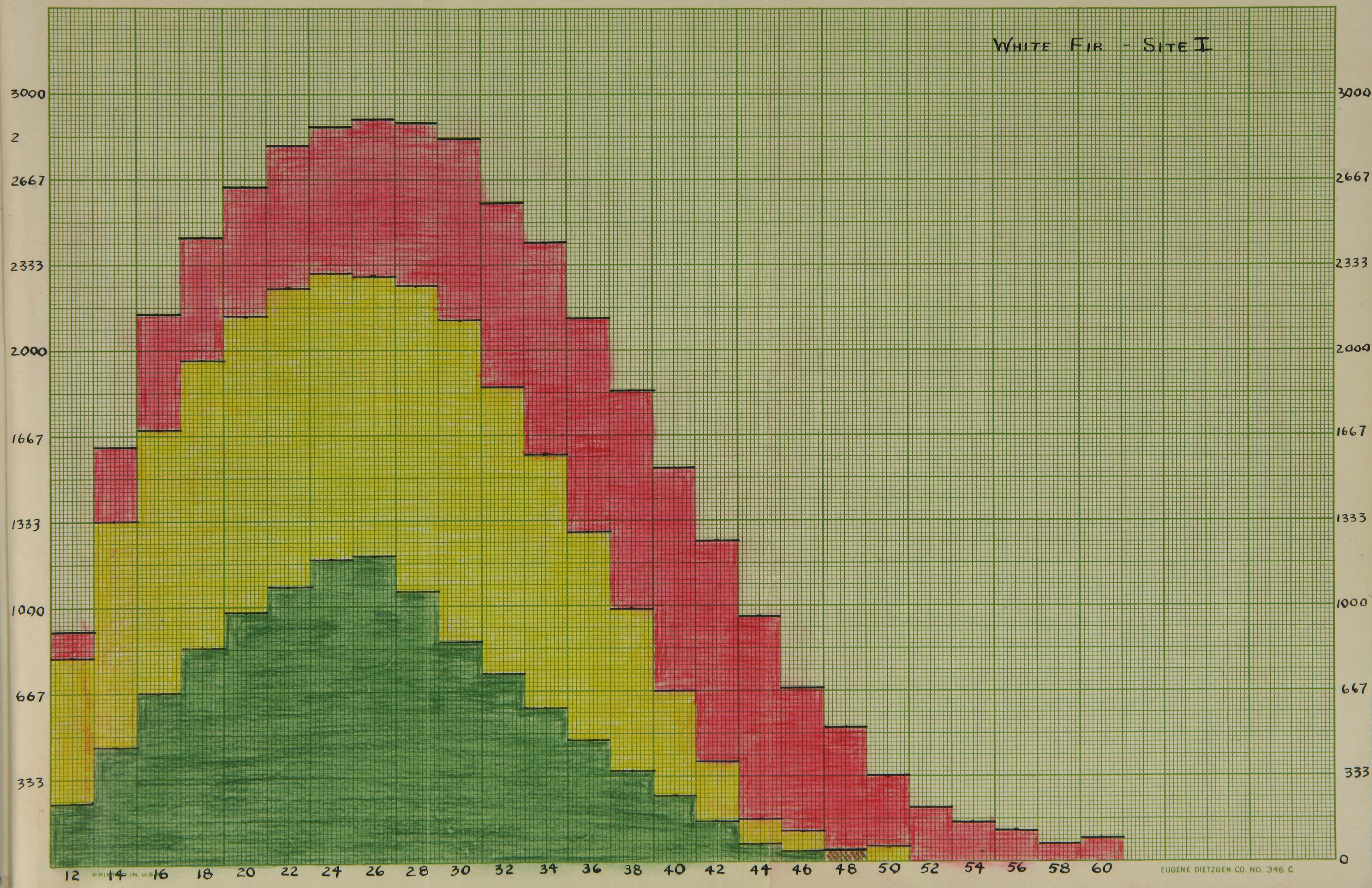
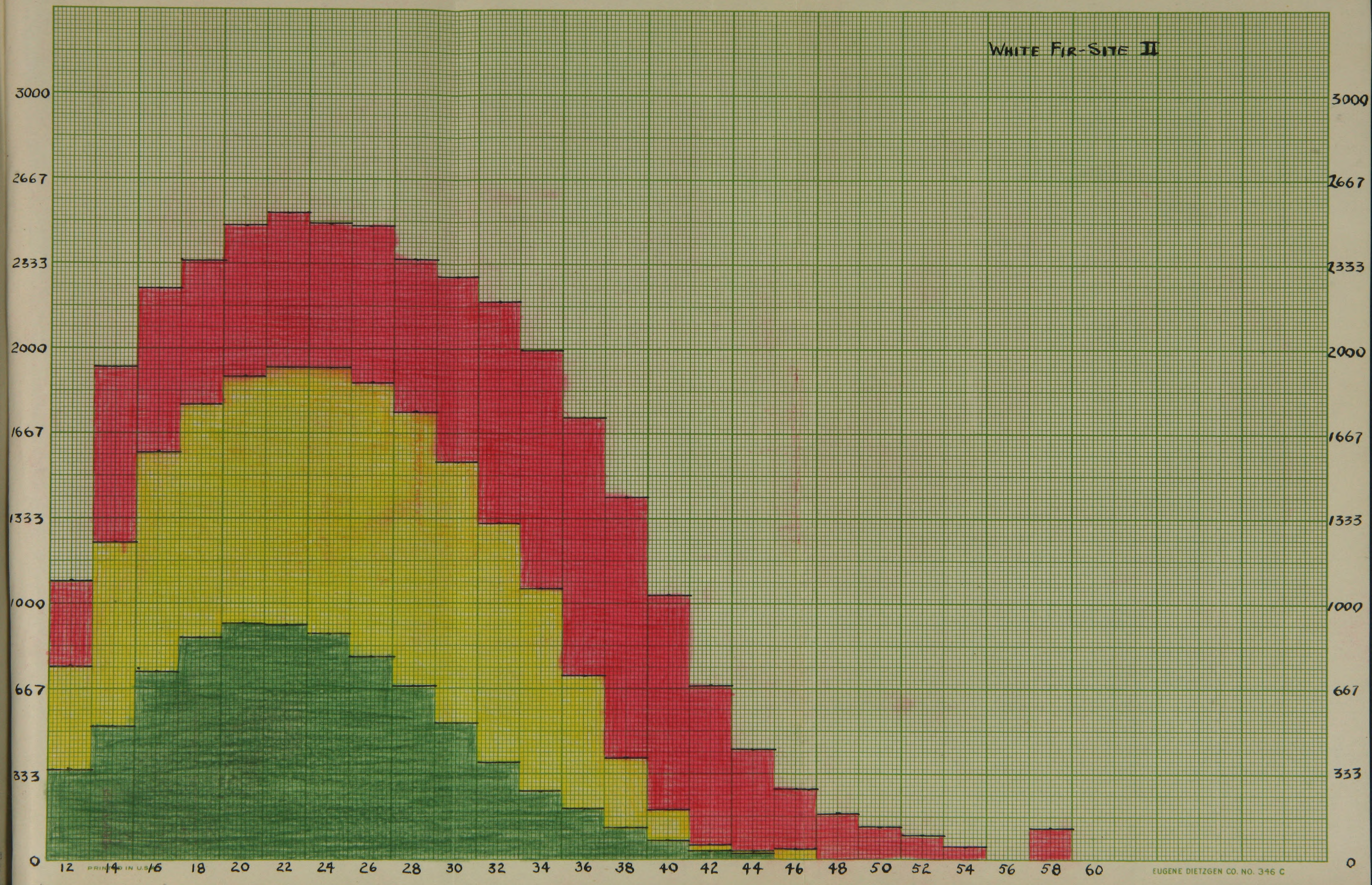
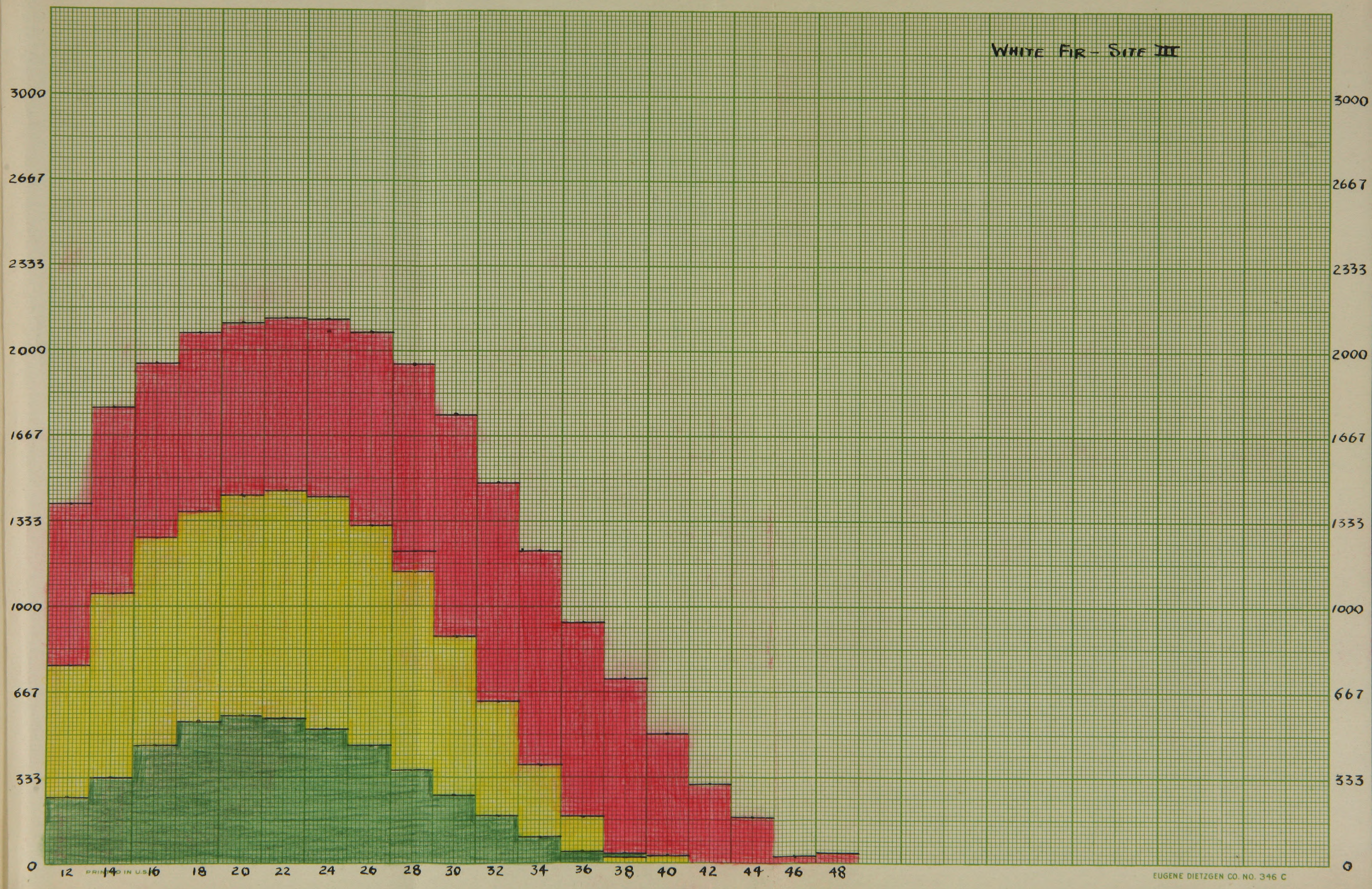
Following is a diagramatical representation of volumes per diameter class, Scribner Decimel C, on three sites, with three degrees of stocking on each site, for the true fir type as found in this forest.

That volume, on each site quality, which would be found under conditions of poor stocking is shown in green on the bar graphs. The additional volume which would be found in each diameter class with a condition of medium stocking is shown in yellow. Likewise, the additional volume which would be found in each diameter class with a condition of heavy stocking is shown in red.



WHITE FIR - SITE I
3000
2
2667
2333
2000
1667
1333
1000
667
333
0
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
EUGENE DIETZGEN CO. NO. 346 C


WHITE FIR-SITE II
3000
2667
2333
2000
1667
1333
1000
667
333
0
12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60
PRINTED IN U.S.A.
EUGENE DIETZGEN CO. NO. 346 C


WHITE FIR - SITE III
3000
2667
2333
2000
1667
1333
1000
667
333
0
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
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